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Molluscan Research

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The Malacological Society of Australia)

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Contents

W.B. Rudman
The Chromodorididae (Opisthobranchia: Mollusca) of the Indo-West Pacific: further species from New Caledonia and the *Noumea romeri* colour group 1

A.H. Scheltema
Falcidens poias, a new species of chaetoderm Aplacophora from Rottnest Island, Western Australia (Chaetodermorpha, Chaetodermatidae) 45

E.H. Vokes
Two additional species of *Dermomurex* (Gastropoda: Muricidae) from southern Australia 51

A.M. de Frias Martins
A new species of *Pythia* Röding, 1798 (Pulmonata, Ellobiidae) from New Ireland, Papua New Guinea 59

B. Scott
Redescription of *Fastosarion superba* (Cox, 1871), with descriptions of two new species of *Fastosarion* from northern Queensland (Pulmonata: Helicarionidae) 69

K.L. Lamprell and R.N. Kilburn
The Recent Spondylidae of South Africa and Mozambique, with the description of a new species (Mollusca, Bivalvia, Pectinoidea) 81

Book review 97

Instructions to authors 103

Moll. Res. 16: 1–43 (1995).

The Chromodorididae (Opisthobranchia: Mollusca) of the Indo-West Pacific: further species from New Caledonia and the *Noumea romeri* colour group.

W.B. Rudman
The Australian Museum
6-8 College St, Sydney, New South Wales 2000
Internet: billr@amsg.Austmus.oz.au

Eleven new species of chromodorid nudibranch are described from New Caledonia. There are three new species of *Glossodoris*, four of *Hypselodoris*, and single species of *Cadlinella*, *Noumea*, *Durvilledoris*, and *Thorunna*. Pink species with a white border are compared as the '*Noumea romeri* colour group' and new species of *Noumea*, *Durvilledoris* and *Hypselodoris* which fall into that colour group are compared with *Noumea romeri, N. simplex, Thorunna speciosus, Hypselodoris rosans*, and *Chromodoris albolimbata.*

Keywords: Chromodorididae, Opisthobranchia, *Cadlinella*, *Glossodoris*, *Noumea*, *Durvilledoris*, *Hypselodoris*, *Thorunna*.

Introduction

This is one of a series of papers (Rudman, 1982, 1983a,b, 1984, 1985, 1986a–c, 1987, 1988, 1990, 1991) clarifying the taxonomy of the Chromodorididae in the Indo-West Pacific. Eleven new species from six genera are described. Most of the material described results from a broader study in progress, preparing a monographic review of the opisthobranch fauna of New Caledonia. Colour photographs of all the species described in this paper will be published in that work.

In an earlier study (Rudman, 1984), the identity of two very similarly coloured species, pink with a white mantle border, (*Noumea romeri, N. simplex*), was clarified. In this paper, seven more similarly coloured species are identified, and the nine species are compared as the '*Noumea romeri* colour group'.

A second species of *Cadlinella* Thiele, 1931, is described. It is most probably the same as a species misidentified by Bergh (1874) as *Doris eolida* Quoy & Gaimard, 1832, and on which he based a genus name *Echinodoris.* The nomenclatural problems associated with this, and the identity of *Doris eolida* are discussed.

Three further species of *Glossodoris* Ehrenbergh, 1831, two of which have colour similarities to the *Glossodoris cincta* group (Rudman, 1986a), are described, as are single species of *Noumea* Risbec, 1928, *Durvilledoris* Rudman, 1984, and *Thorunna* Bergh, 1878. Also included are four new species of *Hypselodoris* Stimpson, 1855.

Methods

A full account of the methods adopted in this study is included in the first paper in this series (Rudman, 1982). All specimens were either seen by me alive or were accompanied by colour photographs. Full dissections of the general anatomy, and in

particular the alimentary canal and reproductive system, were made where possible, and the characters used and the reasons for generic placement follow my generic review (Rudman, 1984) and subsequent papers listed in the Introduction.

Most of the material in this study is from the collections of ORSTOM, Noumea, or if collected by me, it is with the assistance of staff from either ORSTOM or the Museum National d'Histoire Naturelle, Paris. Consequently most of the material is deposited in the collections of that museum. Because they have no specimen registration system, some specimens have been given Australian Museum registrations for ease of handling and identification. Specimens with only an 'AM C' registered number are deposited in the Australian Museum, Sydney, while those with or without an 'AM C' registered number, but carrying the notation '(in MNHN, Paris)' are deposited in the collections of the Museum National d'Histoire Naturelle, Paris.

To assist in the later identification of unregistered material I have added collection numbers, where present, in the Material sections. The prefix 'MG' refers to specimens collected by P. Laboute in New Caledonia, and a 'P' to material collected by him in French Polynesia. Specimens with an 'F' prefix were collected by L. Faucompré.

Descriptions

Cadlinella hirsuta n.sp.

(Figs 1–5, 6B, 7)

Echinodoris eolida: Bergh, 1874 : NOT *Doris eolida* Quoy & Gaimard, 1832.

Cadlinella sp., Laboute, Feuga & Grandperrin, 1991: 43.

Material: New Caledonia. (1) Canal Woodin, S Lagoon, (st 252), 4m, 20 June 1979, 2 specimens, coll: P. Laboute (only photographs available). (2) Canal Woodin, Baie Iré, S Lagoon, night, 15m, 13 July 1989, 1 small specimen, coll: P. Laboute (photograph

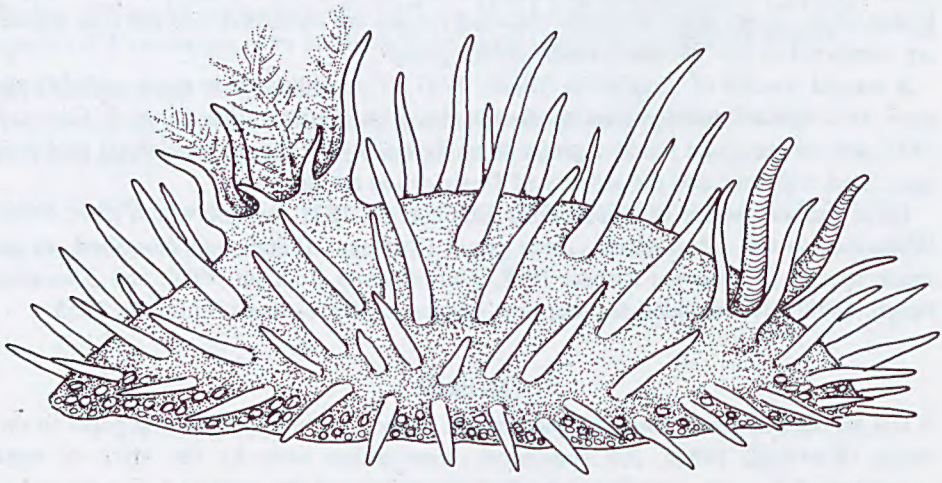

Figure 1. *Cadlinella hirsuta* sp. nov., Koumac, New Caledonia, 15mm long alive (AM C200627).

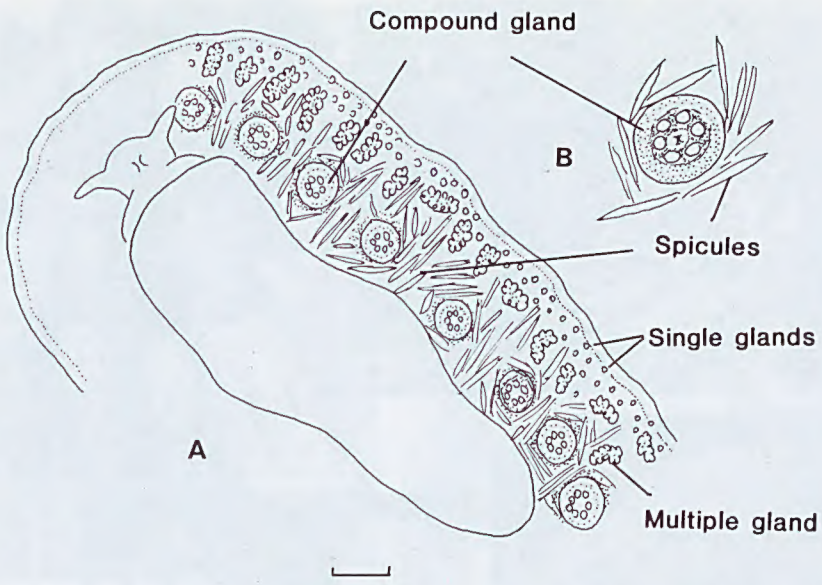

Figure 2. *Cadlinella hirsuta* sp. nov., (AM C200627); A, ventral view of mantle skirt showing arrangement of the three mantle gland types. Scale = 1mm. B, enlarged compound gland (not to scale).

only). (3) Baie du Prony, (western arm), S Lagoon, 25m, 25 mm long preserved, 29 August 1987 cfMG183, coll: P. Laboute, HOLOTYPE, AM C167744 (in MNHN, Paris). (4) Banc Gail, between Noumea and Ile Ouen, S Lagoon, 30m, 30 March 1988, cfMG183, coll: P. Laboute, PARATYPE, AM C167745. (5) Passe de Koumac, east face, 20°40.4'S, 164°14.9'E, 26–40m, 15mm long alive, 25 October 1993, PARATYPE, AM C200627. Chesterfield Reefs. (6) Bellona Reefs, 60–80m, August 1988, MG183, coll: P.Laboute, PARATYPE, AM C167746 (in MNHN, Paris).

Description:

Colour: (Fig. 1) The mantle is a deep translucent yellow, covered with long, opaque white, tapering papillae. The papillae have a translucent clear basal band and in one specimen the upper third of each papilla is pink. The gills and rhinophores are translucent white. On the mantle skirt small whitish mantle glands can be seen through the mantle wall. There is a narrow translucent clear band around the mantle edge. The underside of the mantle is translucent yellow and the opaque white clusters of the mantle glands can be clearly seen. Also visible are the network of transparent mantle spicules. The body and foot are translucent yellow with a narrow translucent clear border around the edge of the foot.

Shape: (Figs 1, 2) The mantle is ovate and completely covers the relatively high rounded body. All over the mantle are scattered long tapering papillae. They are larger in the central region, appearing shorter and more closely packed nearer the mantle edge. Also around the mantle edge can be seen little raised bumps, corresponding to the positions of the sub-epidermal mantle glands. A network of colourless spicules are found throughout the mantle and its associated papillae.

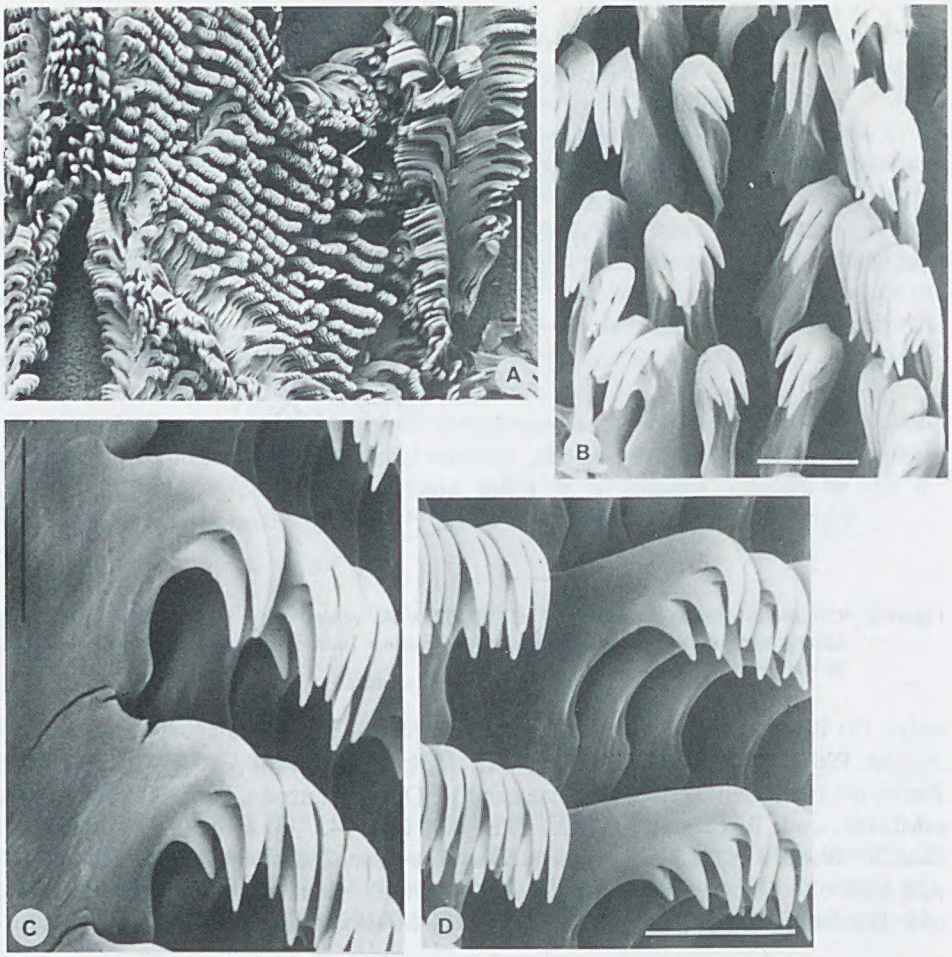

Figure 3. *Cadlinella hirsuta* sp. nov., Koumac, New Caledonia, 12mm long preserved (AM C200627), scanning electron micrographs of radula. A, Central region and right half of radula; B, Central region showing central tooth and innermost laterals on each side; C, Inner side of innermost right lateral teeth; D, Inner side of mid-lateral teeth on right side. A, scale = 100 μm; B–D, scale = 10 μm. Photo: A.C. Miller.

The mantle glands are arranged in three bands around the mantle skirt. At the edge is a region with small irregularly scattered glands. Inside this the small individual glands are arranged into tightly packed clusters. Embedded deeply in the mantle tissue, near the body, is a third gland type, a compound gland consisting of a translucent ring (of connective tissue or muscle) surrounding a ring of white spherical glands (Fig. 2). There is a pore in the centre of these compound glands, which opens ventrally on the mantle skirt. There are about eight of these compound glands down each side of the mantle. When irritated, all the white spheres are extruded out of the central pore. The glands sit in a network of clearly visible spicules.

The rhinophore clubs are long and tapering, and the six long simple gills form a circle around the anus.

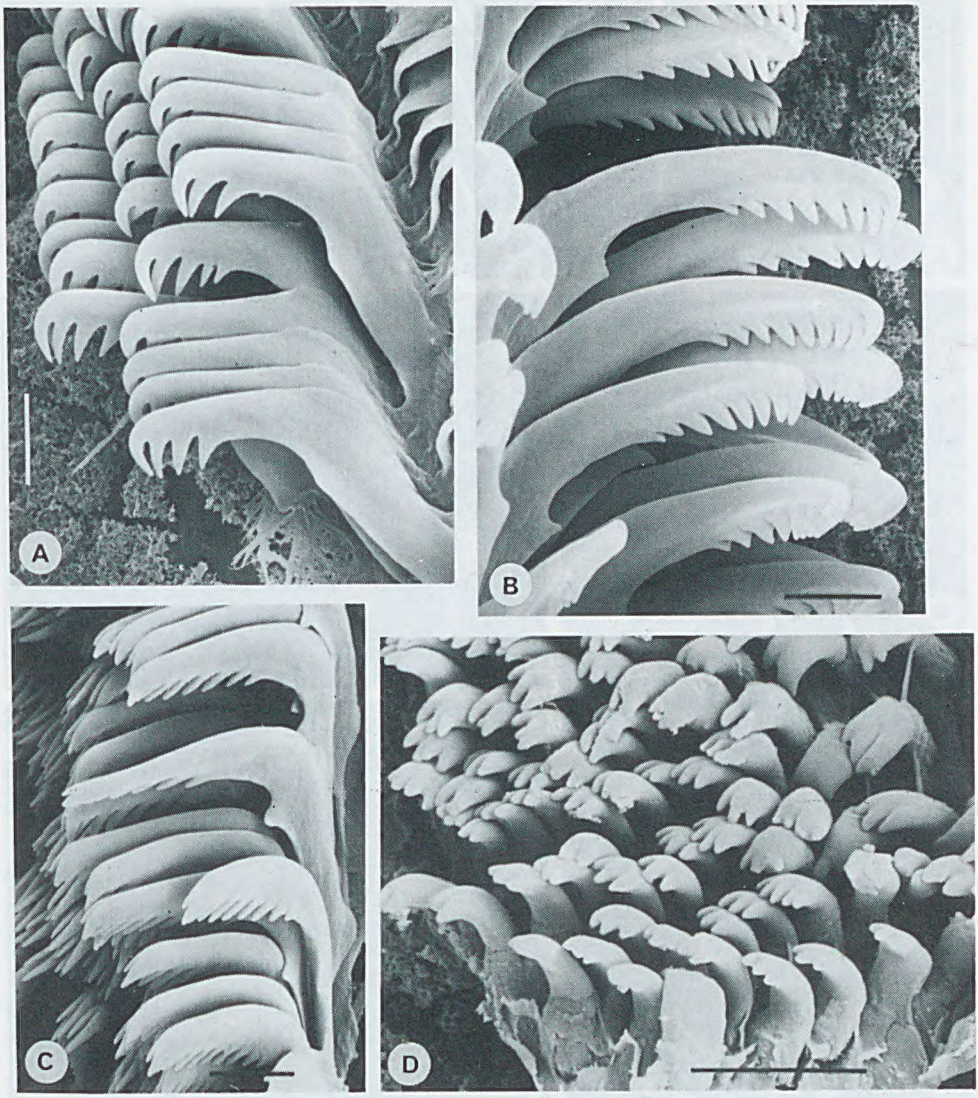

Figure 4. *Cadlinella hirsuta* sp. nov., Koumac, New Caledonia, 12mm long preserved (AM C200627), scanning electron micrographs of radula. A, outside of inner right lateral teeth; B, inner side of outer right lateral teeth; C, outside of outer right lateral teeth; D, jaw rodlets. Scale = 10 μm in all cases. Photo: A.C. Miller.

Buccal armature: (Figs 3–5, 6B) The oral tube and buccal bulb are of similar length. The radular formula of one specimen, 25mm long preserved (C167745) is 36.1.1.1.36 x 62, and of a second, 12 mm long preserved (C200627) is 87.1.87 x 81. The radular description is based on both specimens but the central region of the former specimen is apparently aberrant (Pl.5, figs A–C) with a central tooth with a broad triangular plate and a pair of multicuspid 'blades'. The innermost laterals on each side are also much larger than the adjacent lateral teeth and have a broad pointed cusp with a rounded denticulate blade on each side. As the central region of the second specimen is very

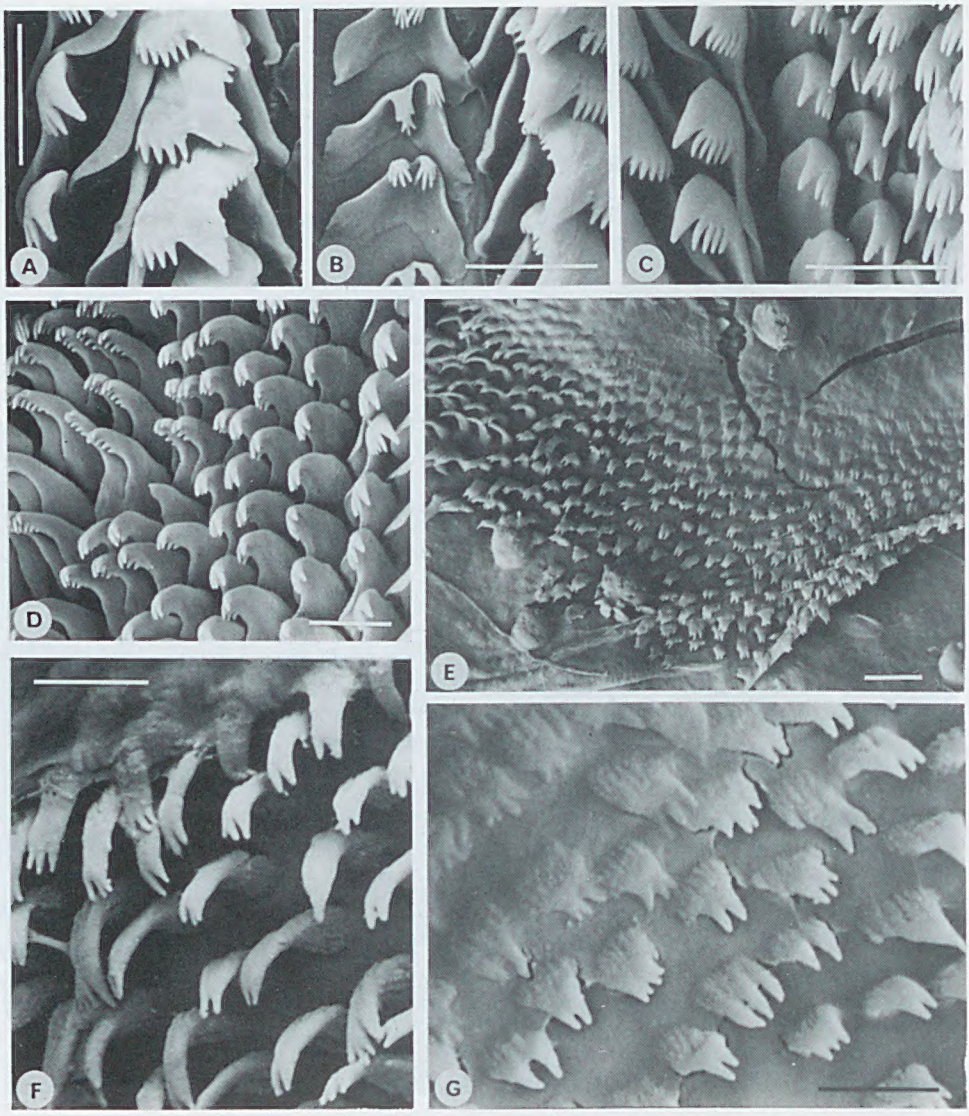

Figure 5. *Cadlinella hirsuta* sp. nov., Banc Gail, S. Lagoon, New Caledonia, 25 mm long preserved (AM C167745), scanning electron micrographs of radula. A–C, Showing aberrant teeth in central region of radula; A, innermost left lateral tooth; B, Central tooth and innermost right lateral tooth; C, Teeth 2–6 on right side; D, inside of left lateral teeth from Tooth 2; E–G, section of jaw plate showing individual rodlets. A–E, scale = 20 μm; F,G, scale = 10 μm. Photo: A.C. Miller.

similar to that of *Cadlinella ornatissima* (Risbec, 1928), I have assumed that this represents the normal tooth morphology of the species.

In that specimen there is a well developed central tooth. It is about two-thirds the height of the adjacent lateral teeth and has four large pointed cusps, the central pair being slightly larger than the outer pair. Tooth 1 on each side is similar in shape to the central tooth with two large symmetrical pointed cusps and a third smaller cusp on the

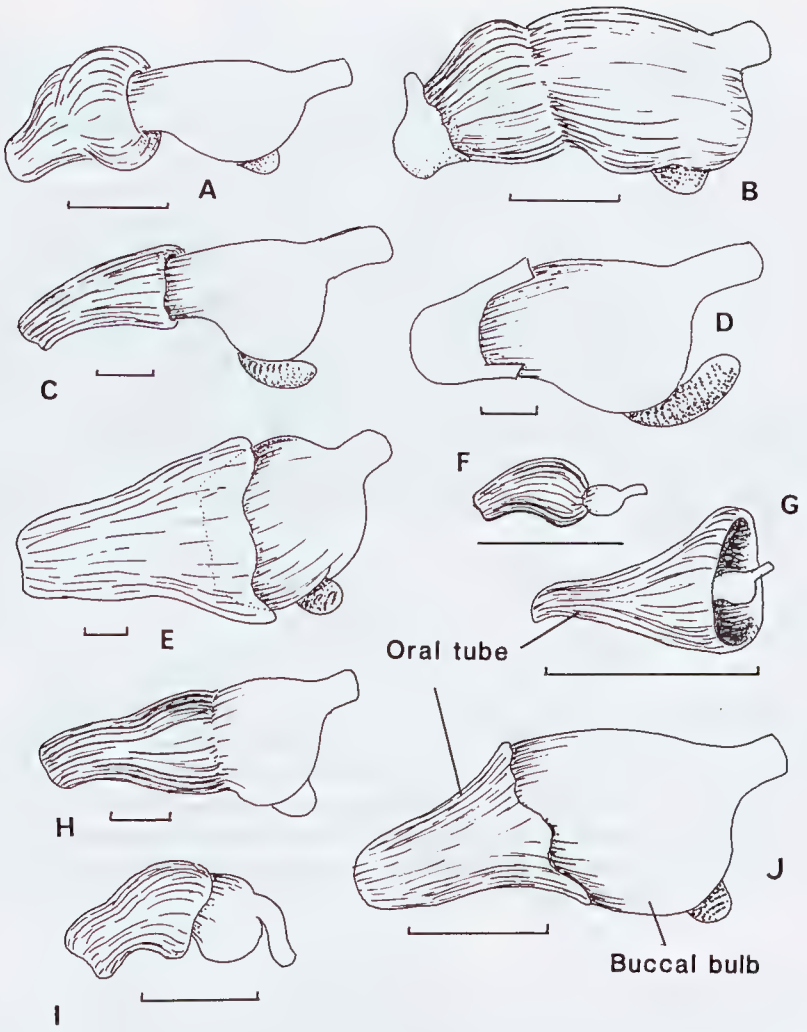

Figure 6. Foregut anatomy showing relative lengths of oral tube and buccal bulb. A, *Glossodoris pullata* sp. nov. (AM C167979); B, *Cadlinella hirsuta* sp. nov. (AM C200627); C, *Hypselodoris koumacensis* sp. nov. (Holotype); D, *Glossodoris aeruginosa* sp. nov. (AM C167978); E, *Glossodoris aureola* sp. nov. (AM C200595); F, *Durvilledoris albofimbria* sp. nov. (AM C200617); G, *Thorunna montrouzieri* sp. nov. (AM C200701); H, *Hypselodoris flavomarginata* sp. nov. (AM C168011); I, *Noumea verconiforma* sp. nov. (AM C200499); J, *Hypselodoris punicea* sp. nov. (AM C200618). Scale = 1 mm in all cases.

inside. There are no outer cusps or denticles. Tooth 2 is also of similar size, and has two large pointed cusps, but it has a third, smaller, outer cusp and no inner dentition. From Tooth 3–20 the two large cusps dominate the tooth morphology, but there are also two or three large outer cusps which grade in size, the one adjacent to the terminal pair being of equal size and the others progressively smaller. From Tooth 20 the teeth become more laterally flattened and the bicuspid nature of the tip of each tooth changes with the inner of the upper two cusps becoming terminal and the outer cusp falling below it on the outer edge of the tooth. Below this cusp there is a row of up to seven

smaller 'cusps' or denticles gradually decreasing in size. The outer ten teeth are reduced in size and bear a row of thin pointed terminal denticles.

The jaw rodlets have a recurved bifid tip. They are not well developed and the recurved rodlets are not closely packed. Many rodlets have a bicuspid tip, but there are some that are unicuspid and a sizeable minority with three or even four cusps.

Reproductive system: (Fig. 7) The vagina is relatively wide and short, narrowing to form a short duct to the large spherical gametolytic sac. From the gametolytic sac, the exogenous sperm duct leads to the fertilisation chamber within the female gland mass. Approximately halfway along its length a short branch leads to the ovate exogenous sperm sac. The penial bulb is large and muscular, two to three times the length of the vagina. At the base of the penial papillae, a section of the thin muscular vas deferens is encased in the musculature of the penial bulb. In a whole mount of this region, cleared with glycerine, this section of the duct can be seen to be lined with closely packed, anteriorly facing microscopic spines. Presumably if this section is everted during copulation they would act as barbs. It is joined to the folded tubular prostate gland by a relatively short vas deferens.

Remarks: In all anatomical features this species matches the anatomy of *Cadlinella ornatissima*. The main difference is the development of the dorsal tubercles of *C. ornatissima* into long tapering papillae in *C. hirsuta*. A good colour illustration of this species has recently been published (Laboute, Feuga & Grandperrin, 1991).

Cadlinella hirsuta is almost certainly the same, or congeneric with the specimen identified by Bergh, (1874) as *Doris eolida* Quoy & Gaimard, 1832, and placed in the new genus *Echinodoris*. Bergh's specimen, collected near Taiwan (Museum Godeffroy collection), had no accompanying information on the living animal. Despite that, its anatomical features, (including the description of the compound mantle glands as oval pits) match *Cadlinella hirsuta* well. Unfortunately, although no specimen of Quoy &

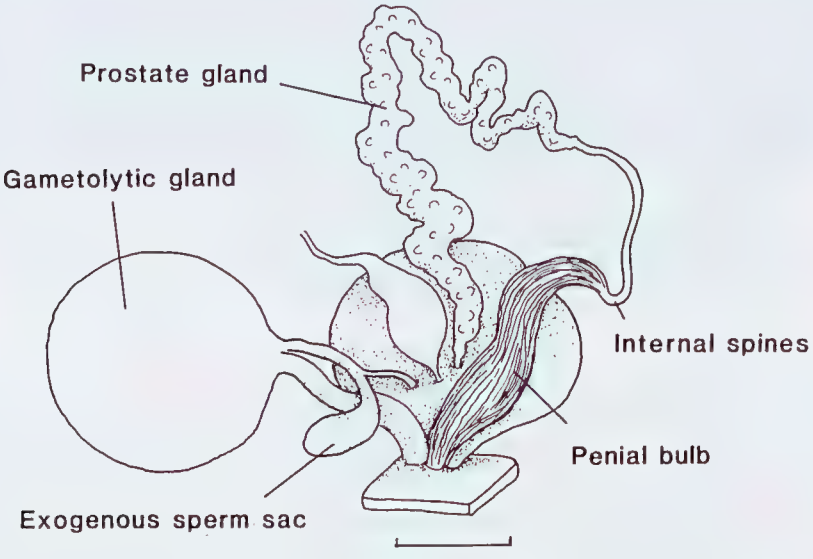

Figure 7. *Cadlinella hirsuta* sp. nov. (AM C200627), Reproductive system. Scale = 3 mm.

Gaimard's *Doris eolida* can be found, the evidence suggests that Bergh's identification was incorrect.

The original description of *Doris eolida* is of a very small animal (2 lines long – approx 5mm) found on floating *Fucus* in the tropical Pacific. Animals found living on floating brown algae are almost certainly to be feeding on hydroid or bryozoan colonies attached to the algae. The description of rhinophores and a circlet of gills indicates a dorid nudibranch, and if so, a bryozoan feeder. One common dorid bryozoan feeder which is often found associated with bryozoan colonies on brown algae is *Hopkinsia plana* (Baba, 1960). In external shape and anatomy it fits well, except that the spots in *H. plana* are reddish brown, not the bright red illustrated by Quoy & Gaimard. Considering the conditions that they were working under, and not knowing whether their colour description was based on the published water colour, or vice versa, it is most probable that *Doris eolida* and *H. plana* are synonyms. As I have summarised in the accompanying synonymy of '*Doris eolida*' (Table 1), this presents us with a major nomenclatural problem. Bergh erected a new genus *Echinodoris* for Quoy & Gaimard's species, but based on the features of his misidentified specimen. Bergh also knew that Gray (1850) had already erected *Ceratodoris* for the same species. His justification for ignoring Gray's name was that it was 'characterised totally incompletely and carelessly' (translation from German). A consequence of this is that *Hopkinsia* becomes a junior subjective synonym of both *Ceratodoris* and *Echinodoris*, the former taking precedence, since both had *Doris eolida* as the type specimen. The specimen identified incorrectly by Bergh as *Doris eolida* is most probably *Cadlinella hirsuta*. As Bergh's name *Echinodoris* is based on a misidentified type species its status can only be determined by the International Commission on Zoological Nomenclature (Art 70(b),3rd Ed). I am submitting a proposal that *Echinodoris* should be treated as a junior objective synonym of *Ceratodoris*, and in the interests of nomenclatural stability not be considered available to replace *Cadlinella*. I will also propose that both *Echinodoris* and *Ceratodoris*, both effectively unused since introduction, be suppressed thus stabilising the well-used name *Hopkinsia*.

It is also possible that *Echinodoris armata* Eliot, 1913 from Japan is congeneric or even conspecific with *Cadlinella hirsuta*. However it is based on one preserved specimen, without any information on the colour of the living animal. There are no illustrations accompany Eliot's brief anatomical notes. It differs in lacking a central radular tooth. With so little information there seems litle value in attempting to identify it.

TABLE 1: Synonymy of *Hopkinsia eolida* (Quoy & Gaimard)

Doris eolida Quoy & Gaimard, 1832: 263–4, Pl.18, figs 11–15.

Ceratodoris eolida: Gray, J.E., 1850: 103 – type by monotypy of new genus *Ceratodoris*; Adams & Adams, 1858: 52, 632 (Vol 2), Pl.62, fig 6 (Vol 3).

Echinodoris eolida: Bergh, 1874: 109–112, Pl.3. figs 4–20 – type by monotypy of new genus *Echinodoris* (but specimen on which Bergh based his description is not *Doris eolida* Quoy & Gaimard, but probably *Cadlinella hirsuta* sp. nov.).

Okenia plana Baba, 1960: 80–81, Pl.7, figs 2a–d.

Hopkinsia plana: Bouchet & Ortea, 1983: 230–232, Rudman & Darvell, 1990: 37–38, Pl. 1F (– for full synonymy). If Bouchet & Ortea's view that this species should be placed in the genus *Hopkinsia* MacFarland, 1905 (redefined to include *Hopkinsiella* Baba, 1938), then the genus *Hopkinsia* is a junior synonym of *Ceratodoris*.

Glossodoris pullata sp.nov.
(Figs 6A, 8, 9, 10A)

Material: (1) Passe d'Ouaraï, near La Foa, W Lagoon, New Caledonia, 17m, 23 December 1985, submarine arch, HOLOTYPE, 50mm long alive, coll: L. Faucompré, F073, AM C167979, (in MNHN, Paris). (2) Tahiti, outer reef W, 30m, 17 January 1984, night, PARATYPE, 39 mm long preserved, P011, coll: P.Laboute, (in MNHN, Paris).

Description:

Colour: (Fig. 8) The colour description is based on photographs and the preserved specimen from La Foa (C167979). The background colour of the mantle is translucent white. There is a reticulate pattern of brown covering all but the outer part of the mantle skirt. The brown reticulate pattern is very irregular and could be described as brown with a dense mottling of irregular sized white patches, many slightly raised. Outside the reticulate region is a broad band of opaque white which merges with a dark narrow band at the mantle edge. This dark band is a diffuse translucent brown on the inside edge where it merges with the white, but changes to black at the mantle edge. The rhinophore pockets are edged in black, and although not visible in photographs, the preserved animal has traces of black lining the gill pocket.

The rhinophore stalk is opaque white and the club is black, except for a translucent white tip. The gills are translucent white with some opaque white mottling, and the edges are lined with dark brownish-black. The underside of the body cannot be seen in photographs but in the preserved specimens the edge of the foot is also lined black. No other pigmentation is visible.

In another specimen, from Tahiti, the brown reticulate pattern between the opaque white mottlings is much less regular and the colour of the reticulations is replaced in some parts of the mantle by translucent regions where the brownish viscera can be seen through the dorsal body wall.

Shape: (Fig. 8) There is a broad mantle overlap with the edge of the skirt being thrown into sinuous folds, with one major semi-permanent fold halfway down each side of the body. The dorsal surface of the mantle, especially in the central region, has many slightly raised bumps corresponding to the opaque white patches. The gills are arranged in a horse-shoe pattern around the anal papilla, each end of the row forming a slightly raised spiral. The basal third of the gills are quadrangular in section but they thin to a simple planar structure in the outer two-thirds. The arrangement of the gills, as seen in photographs, suggest that they move rhythmically, as is normal in the genus.

Buccal armature: (Figs 6A, 9) The oral tube and buccal bulb are of approximately equal length and the radular sac protrudes only a small distance in the posterior midline. The radular formula of the specimen, 50 mm long alive, is 36.0.36 x 57, although the central tooth is represented by the trace of a chitinous fold in the midline. The innermost tooth on each side has a pointed cusp with two or three large inner denticles and a similar number of basal denticles on the outside. All the teeth are of similar height, but the cusp lengthens from Tooth 1 to a maximum at about Tooth 10. From there to Tooth 32 the teeth are all of similar size and shape. The outer few teeth

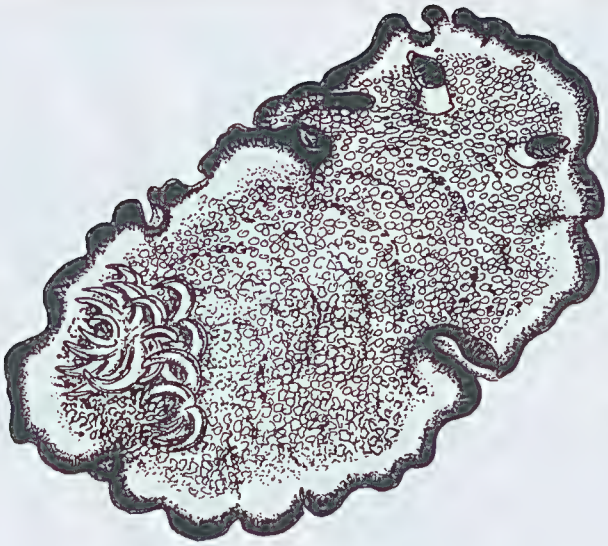

Figure 8. *Glossodoris pullata* sp. nov., La Foa, New Caledonia, 50 mm long alive, (AM C167979).

are reduced in size. From Tooth 2–6 there are two or three prominent basal denticles on the outside. From there the denticles become much smaller and inconspicuous, but increase in number, there being about ten in Tooth 20. From there the number of denticles declines to three in Tooth 32. The outer few teeth have no denticles.

The recurved jaw rodlets have bifid cusps.

Reproductive system: (Fig. 10A) The vaginal duct is long and thin, but uncoiled. It leads to the spherical gametolytic sac and ovate exogenous sperm sac, which are of similar size and open directly into each other. The exogenous sperm duct runs from this junction to the fertilisation chamber in the female gland mass. The penial bulb is long and somewhat folded distally. It is connected to the large convoluted prostate gland by the relatively short narrow muscular ejaculatory duct. No vestibular gland could be distinguished.

Remarks: The radular formula is unlike the narrow radula typical of the genus (Rudman, 1984, 1986a, 1990), but is similar to the group of species, such as *Glossodoris rubroannulata* Rudman, 1986a and *G. symmetricus* Rudman, 1990, with a buccal armature and foregut anatomy reminiscent of *Chromodoris* Alder & Hancock, 1855 (Rudman, 1984).

In shape and colour, this species is similar to *Glossodoris cincta* (Bergh, 1888) and *G. hikuerensis* (Pruvot-Fol, 1954) but differs from both in radular morphology (Rudman, 1986a). The reproductive system is similar to that of *G. hikuerensis*, but in that species the radular teeth are adenticulate and there is a prominent central tooth. In colour, *G. hikuerensis* and *G. pullata* are similar but in the former the dark border is submarginal.

The name '*pullata*' is Latin for wearing mourning dress, a reference to the black band around the mantle edge.

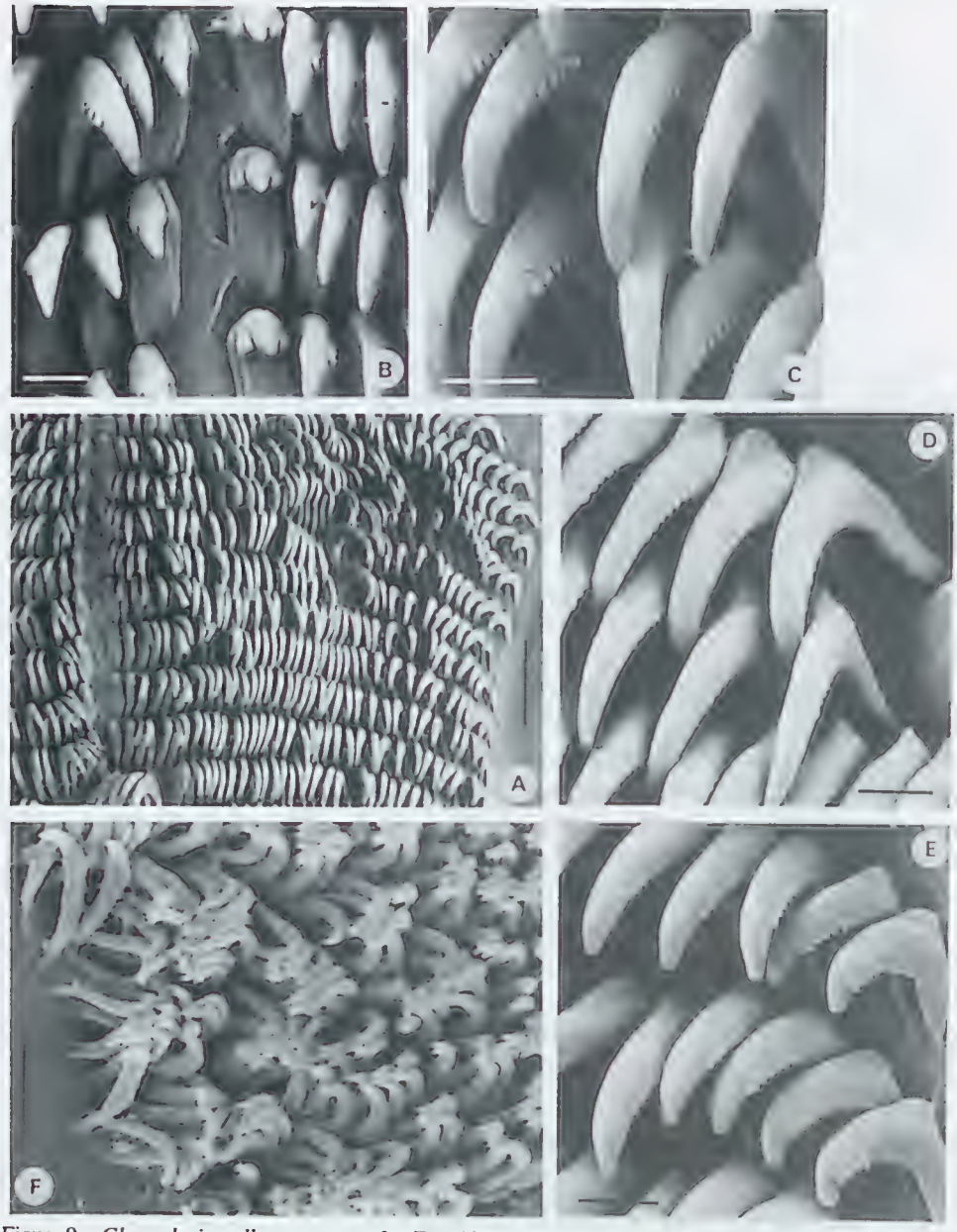

Figure 9. *Glossodoris pullata* sp. nov., La Foa, New Caledonia, 50 mm long alive, (AM C167979), scanning electron micrographs of radula and jaw plates. A, showing central region and right side of section of radula; B, central region; C, inner laterals on right; D, mid-lateral teeth on right; E, outer right lateral teeth; F, jaw rodlets. A, scale = 100 μm; B–F, scale = 20 μm. Photo: A.C. Miller.

Glossodoris aeruginosa n.sp.

(Figs 6D, 11–13)

Material: Banc Gail, S. Lagoon, between Noumea and Ile Ouen, New Caledonia, 30m,

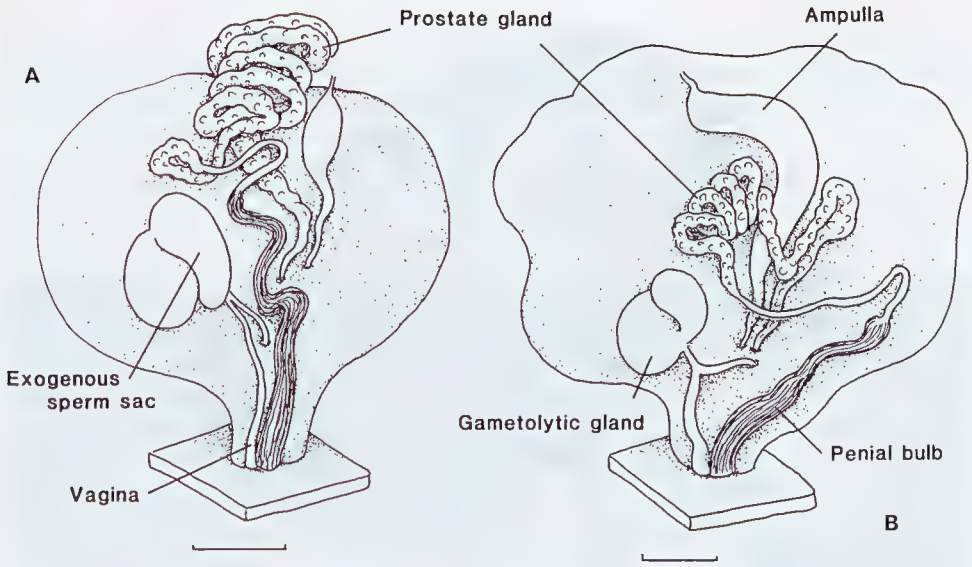

Figure 10. Reproductive system. A, *Glossodoris pullata* sp. nov., (AM C167979); B, *Glossodoris aureola* sp. nov., (AM C200595). Scale = 2 mm in both cases.

21 April 1988, HOLOTYPE, 21 mm long preserved, coll: P. Laboute, MG325, AM C167978, (in MNHN, Paris).

Description:

Colour: (Fig. 11) The colour is based on colour photographs and the preserved specimen. The colour of the mantle is quite complex but is dominated by a regular pattern of raised white patches which vary in size and aspect at different places on the mantle. Each white patch is edged with a narrow brown line. In the mid-region between the gills and the rhinophores, the background is a pale milky green, the white patches are small and rounded and have a tinge of orange brown. The patches are aggregated into clusters leaving some quite large green regions.

Outside the central region, on the mantle skirt, the white patches do not have an orange tinge, and they are aggregated in radially arranged elongate clusters. In these clusters the brown line around each patch is very faint but there is a dark brown line outlining the whole cluster. This gives the mantle skirt an appearance of large elongate white patches, each edged in brown arranged in radiating pattern. Towards the mantle edge the green background colour is replaced with brown, which forms a broken submarginal band. At the edge of the mantle there is a diffuse bluish band which darkens to form a thin black line right at the mantle edge.

The raised rhinophore pockets are translucent brown with scattered whitish patches. The rhinophore stalk is opaque white with traces of brown lines and the rhinophore club is brown with a white line down the posterior midline. The gills are translucent brown with large opaque white patches on the flattened outer face. At its tip, the gill is bilamellate, translucent white, and the two edges are lined with black. The underside of the mantle is a translucent orange-brown with scattered white patches. The foot is also mottled white with a greyish background colour.

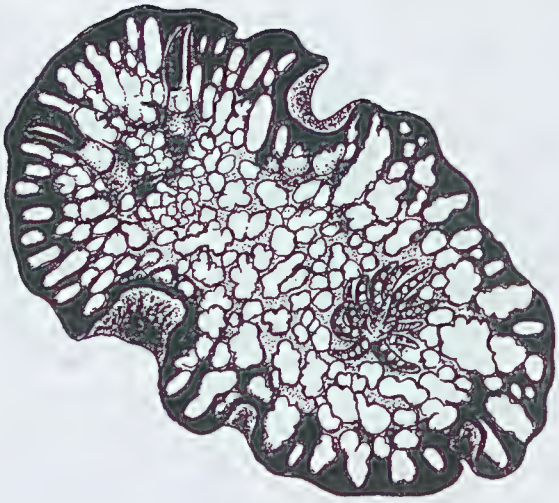

Figure 11. *Glossodoris aeruginosus* sp. nov., Banc Gail, S. Lagoon, New Caledonia, 21 mm long preserved, (AM C167978).

Shape: (Fig. 11) The mantle edge is slightly folded, and about midway down each side is a characteristic large semi-permanent fold. The rhinophore pockets are smooth but raised, and the rhinophore club is relatively elongate. The gills are triangular in cross-section with a flat upper face, except for the tip which is reduced to a simple bilamellate plane.

Buccal armature: (Figs 6D, 12) The oral tube is very short, less than a quarter the length of the buccal bulb. The recurved radular sac is very prominent, protruding some distance behind the buccal bulb in the posterior midline. The radular formula of the specimen, 21 mm long preserved, is 52.1.52 x 158. The well-developed central tooth is about half the height of the adjacent teeth, with a pointed crest and a rounded cusp-like central thickening, sometimes slightly split into two swellings. The first lateral on each side has a wide pointed blade with about ten fine denticles on each side. Teeth 2-5 are similar in size to Tooth 1, but have a more asymmetrical blade, denticulate only on the outside edge. From Tooth 6 the shaft gradually lengthens to reach a maximum at Tooth 19. From there to Tooth 30 it gradually shortens. Teeth 2–19 have many fine denticles along the upper and outer edge of the blade, while from Tooth 20–30, the outer denticles move to the outer base of the blade and are reduced to about 5 in number. From about Tooth 30 the teeth lack denticles, and they decrease in size. The outermost seven teeth gradually reduce in size and shape, the outermost being simple flattened plates.

The cylindrical jaw rodlets are slightly bent and taper to a bluntly pointed, unicuspid tip.

Reproductive system: (Fig. 13) The vagina is a long thin tube, with a series of convolutions about midway along its length. It leads to the large spherical gametolytic sac and an elongate exogenous sperm sac, which open together at its distal end. A short exogenous sperm duct branches from the vaginal duct, near it distal end, to run

to the fertilisation chamber, within the female gland mass. It is not possible to differentiate the penial bulb from the vas deferens, which appear to be combined into a long muscular convoluted tube, gradually decreasing in diameter and running from the common genital opening back to the large folded prostate gland.

Remarks: The radular formula and tooth morphology are similar to that of the *Glossodoris pallida – G. angasi* group of species (Rudman, 1984, 1986a), although the

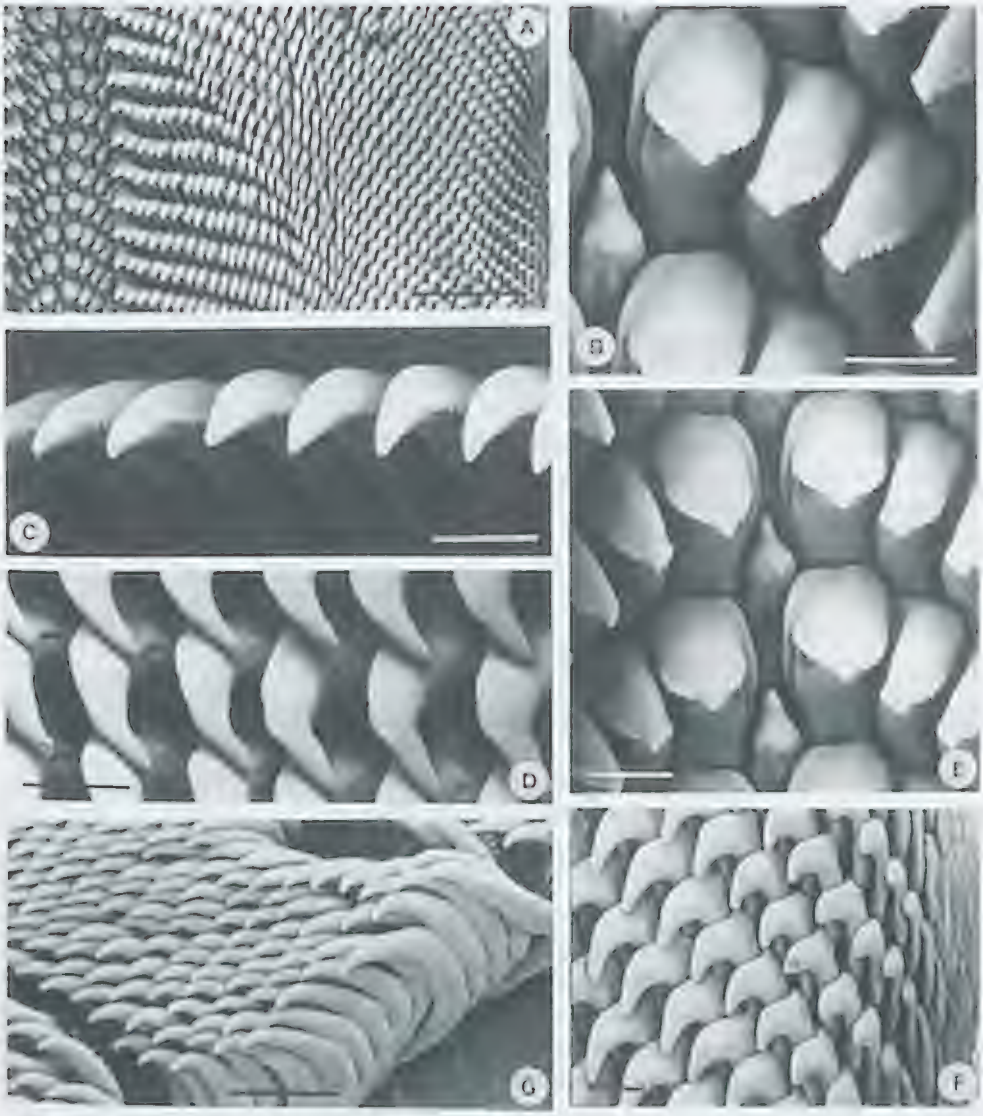

Figure 12. *Glossodoris aeruginosa* sp. nov., Banc Gail, S. Lagoon, New Caledonia, 21 mm long preserved, (AM C167978), scanning electron micrographs of radula and jaw plates. A, central region and right side of section of radula; B, central tooth and inner right laterals; C, outer side of inner right lateral teeth; D, outer side of mid-lateral teeth on right side; E, central region; F, outermost teeth on right side; G, jaw rodlets. A, scale = 200 μm; B–G, scale = 25 μm. Photo: A.C. Miller.

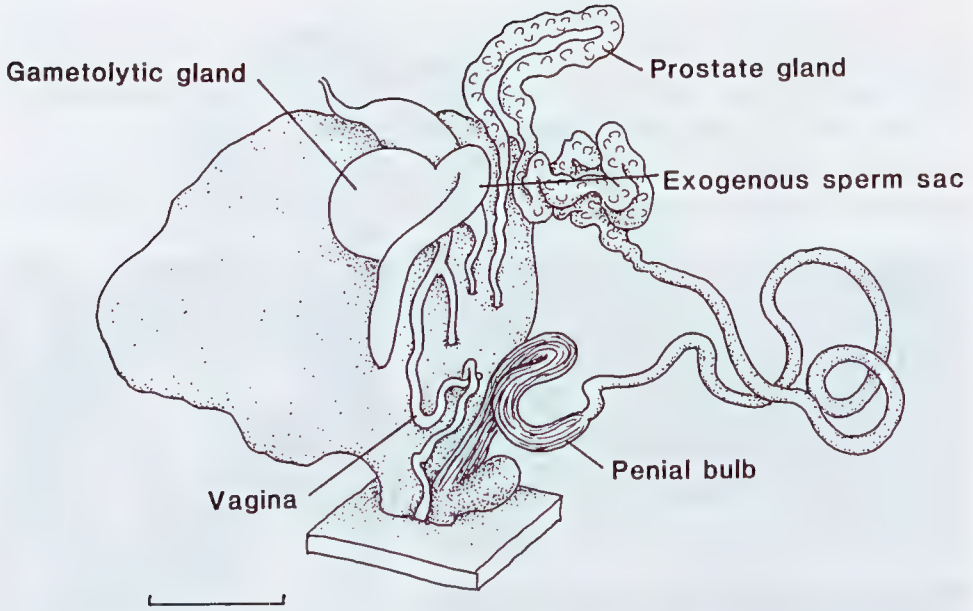

Figure 13. *Glossodoris aeruginosa* sp. nov., (AM C167978), Reproductive system. Scale = 2 mm.

denticles are not as prominent in this species. The reproductive system is also similar to that of the *Glossodoris pallida* group with a pouchlike structure, probably a homologue of the vestibular gland, at the genital opening.

The name '*aeruginosa*' is Latin for being covered in verdigris, the green oxide found on tarnished copper or its alloys. This is a reference to the colour pattern of this species.

Glossodoris aureola n.sp.

(Figs 6E, 10B, 14, 15)

Material: Passe Deverd, outer reef, off Koumac, New Caledonia, 20°45.2'S, 164°15.2'E, 53–71m, dredged in sandy mud, HOLOTYPE, 48mm long alive, 22 Oct 1993, AM C200595, coll: R. von Cosel, (in MHNH, Paris).

Description:

Colour: (Fig. 14) The mantle is translucent white with a thin milky yellow border. The mantle glands appear as a submarginal band of scattered opaque white patches. In the central part of the mantle there are scattered bright orange spots and opaque white dusting. The long and simple gills are translucent clear with an orange core colouring the upper two-thirds. The rhinophore stalk and club is translucent clear except for a band of orange which colours the upper half of the tip, and runs as a diffuse band down the edge of the rest of the club. The gill and rhinophore pockets are not coloured and all the underside of the mantle and the body are translucent white, except for a yellow border to the foot.

Shape: (Fig. 14) There is a broad mantle overlap, the edge of which is greatly folded.

There is also the typical large semi-permanent fold about halfway down each side of the mantle. The simple gills are arranged in an arch around the anal papilla and at each end a few form an inwardly coiling spiral. Some have a few branches near the tip. The gills are extremely long and slender, comparable to those of *Halgerda*. The mantle glands are large and spherical, forming an irregular row just in from the mantle edge.

Buccal armature: (Figs 6E, 15) The oral tube is slightly longer than the buccal bulb, and the radular sac protrudes a slight distance in the posterior midline from the buccal bulb. The radular formula of the holotype, 48mm long alive, is 40./.40 x 90, the central tooth being a small, but distinctive, raised triangular plate. The innermost lateral tooth on each side has a large recurved pointed cusp with four or five pointed denticles along the outer edge. On the inside of the tooth is a large pointed thickening which could be construed as a short inner cusp. In some teeth it has a smooth inner edge but in others it can have up to 3 small denticles. Tooth 2 is similar in size and shape to the innermost tooth but it lacks the inner cusp and inner denticles, and the posteriorly pointing cusp is much straighter. From Tooth 2 the cusp gradually lengthens to reach a maximum at Tooth 7. From Tooth 7 to Tooth 23 the teeth are all of similar size and shape with a prominent pointed cusp and up to eight pointed basal denticles on the outside edge. From Tooth 23 the teeth gradually decrease in size, and the cusp becomes rounded and relatively smaller. The outermost few teeth have a rounded tip with three or four small blunt terminal denticles.

The jaw rodlets are regularly shaped, recurved, and have bifid tips.

Reproductive system: (Fig. 10B) The vagina is a short, thin duct running back to the

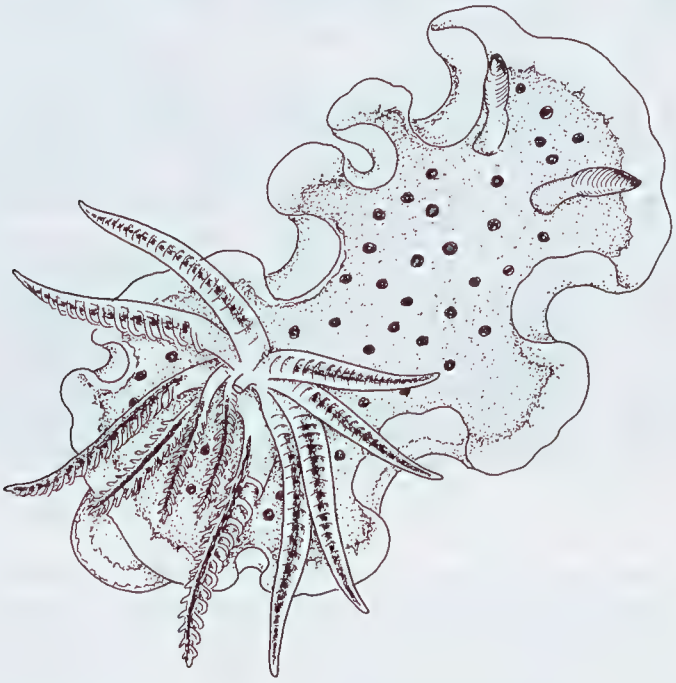

Figure 14. *Glossodoris aureolus* sp. nov., Passe Deverd, off Koumac, New Caledonia, 48 mm long alive, (AM C200595)

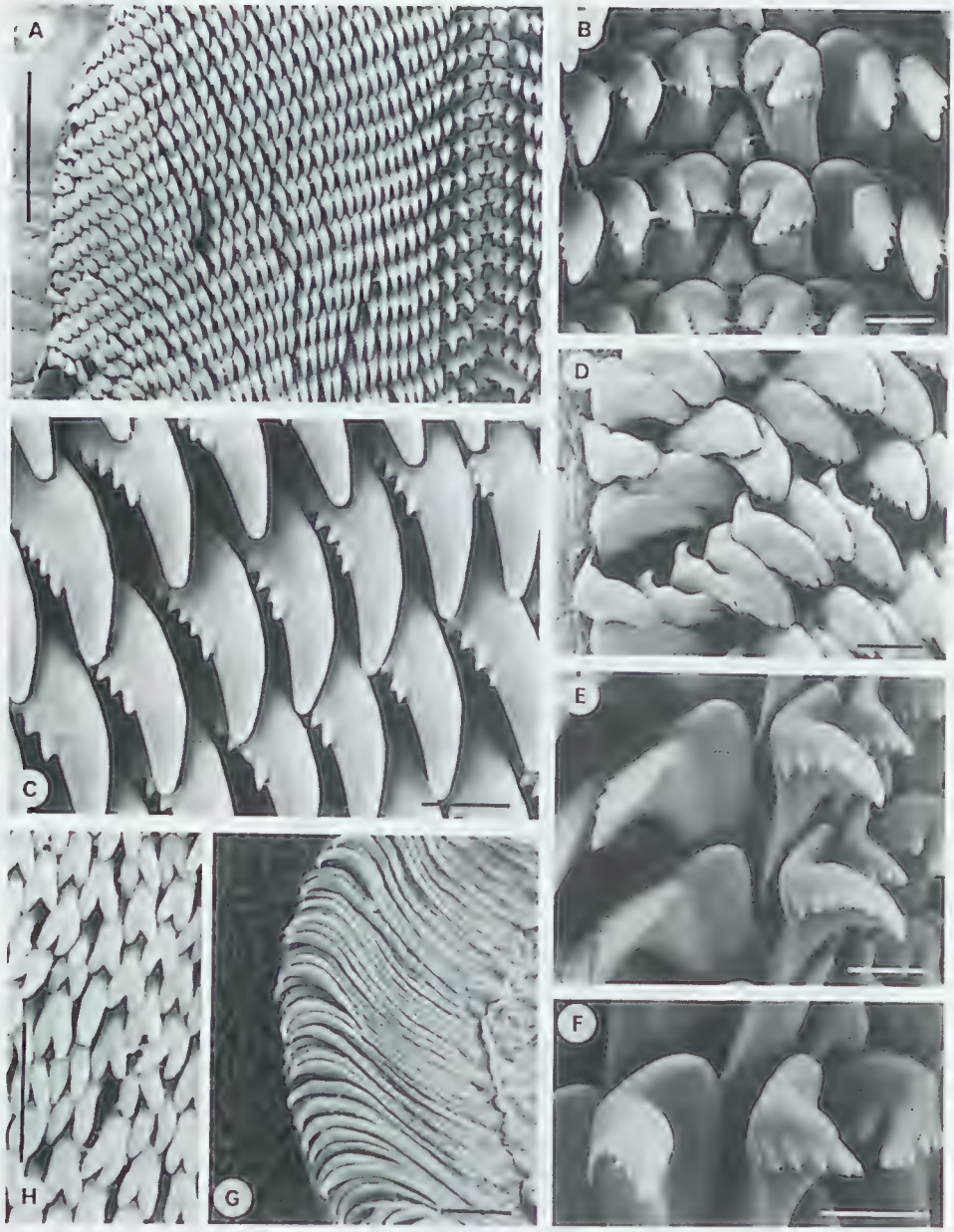

Figure 15. *Glossodoris aureola* sp. nov., Passe Deverd, off Koumac, New Caledonia, 48 mm long alive, (AM C200595), scanning electron micrographs of radula and jaw plates. A, Section of central and left side of radula; B, central region; C, outside view of mid-lateral teeth from left side of radula; D, outermost teeth on left side; E–F, views of central region showing Tooth 1 on right side, and innermost 2 or 3 left teeth; G, section through broken jaw plate showing arrangement of rodlets; H, tips of jaw rodlets. A, scale = 200 μm; B–G, scale = 20 μm; H, scale = 10 μm. Photo: A.C. Miller.

spherical gametolytic sac and the slightly smaller ovate exogenous sperm sac, which have a common vaginal opening. The exogenous sperm duct branches off the vagina approximately three-quarters of the way back. The penial sac is relatively broad and muscular then narrows posteriorly before broadening again at the opening of the vas deferens, a narrow muscular duct which leads back to the very convoluted tubular prostate gland. No sign of a vestibular gland was found.

Remarks: The anatomy of this species clearly places it in the genus *Glossodoris*. In radular morphology it resembles the *G. sedna* subgroup (Rudman, 1986a). No described species of *Glossodoris* has a similar colour pattern.

The name '*aureola*' from the Latin for 'glittering like gold' or 'splendid' is a reference to the bright orange spots on the mantle.

Noumea verconiforma n.sp.

(Figs 6I, 16–18)

Material: NW side of Récif de l'Infernet, 20°35.8'S, 164°12.7'E, 9–10m, in Lagoon, off Koumac, New Caledonia, HOLOTYPE, 6mm long alive, 15 October 1993, AM C200499 (in MNHN, Paris).

Description:

Colour: (Fig. 16) The mantle is translucent white with a reticulate pattern of opaque white, giving a sponge-like appearance to the mantle, similar to that of *Verconia*. Around the edge is a thin band of opaque white. The mantle glands are not visible in the living animal. The rhinophore stalk is translucent clear, while the lower third of the rhinophore club is opaque white and the upper two-thirds bright orange-red. The gills are translucent white with a bright orange-red edge to the upper two-thirds of each gill. The gill lamellae in upper third of each gill (upper 3–4 lamellae) are also lined with orange-red.

The underside of mantle, body and foot are all translucent white.

Shape: (Figs 16, 17B) The mantle is ovate with a relatively broad mantle overlap. Approximately midway down each side the mantle edge folds out. This lateral 'widening' of the mantle is semi-permanent and gives this species, and others which also exhibit this feature, a cross-like appearance. The mantle glands are large, single opaque spheres, easily visible in the preserved specimen. They form an irregular band around the mantle skirt. There are seven simple gills which vibrate rhythmically.

Buccal armature: (Figs 6I, 18) The oral tube and buccal bulb are approximately equal in size and length. The radular formula of the holotype, 6mm long alive, is 14+1.0.1+14 x 22. The innermost lateral tooth on each side is quite different in shape to the other teeth. It has a wide triangular base with a recurved pointed cusp. There are no basal denticles on the inside edge, but there are two large outer denticles at the base of the cusp. The other lateral teeth gradually change in shape from Tooth 2 with a relatively large triangular base and a short blade to the outermost teeth which have a reduced base and a longer elongate shaft or 'blade'. In all these teeth the cusp is reduced to a rounded upper or inner rounded digitiform projection at the tip of the

Figure 16. *Noumea verconiforma* sp. nov., Récif de l'Infernet, off Koumac, New Caledonia, 6 mm long alive, (AM C200499).

blade with approximately 5 similar shaped denticles alongside. While in Tooth 2 the blade has a relatively pointed shape with an inner prominent cusp and 4–5 adjacent outer denticles stepped back evenly from the cusp, by Tooth 5 the shape of the blade resembles that of *Digidentis* where the 'cusp' and 'denticles' are indistinguishable from each other in shape and sit around the curved end of the tooth.

The jaw rodlets are irregular in shape. The shaft forms a large basal cylinder and the recurved tip can have between 2–5 pointed denticles.

Reproductive system: (Fig. 17A) From a relatively broad muscular vestibular region a narrow vaginal duct leads back to the spherical gametolytic sac and ovate exogenous sperm sac. The exogenous sperm sac is approximately twice as large as the gametolytic

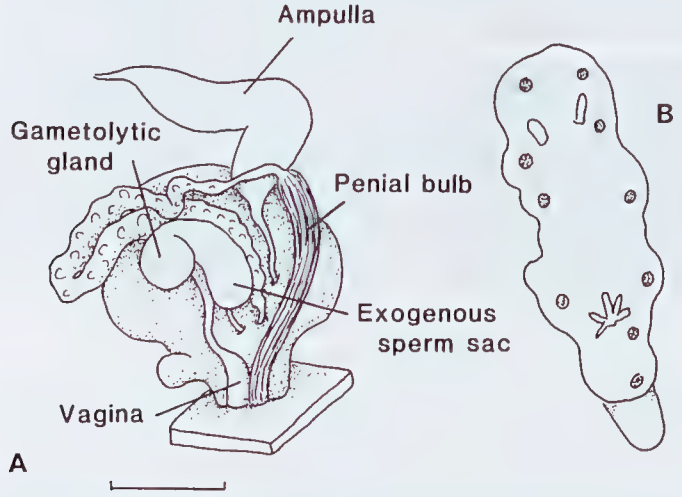

Figure 17. *Noumea verconiforma* sp. nov., 6 mm long alive, (AM C200499). A, Reproductive system (scale = 1 mm); B, whole animal, showing arrangement of mantle glands.

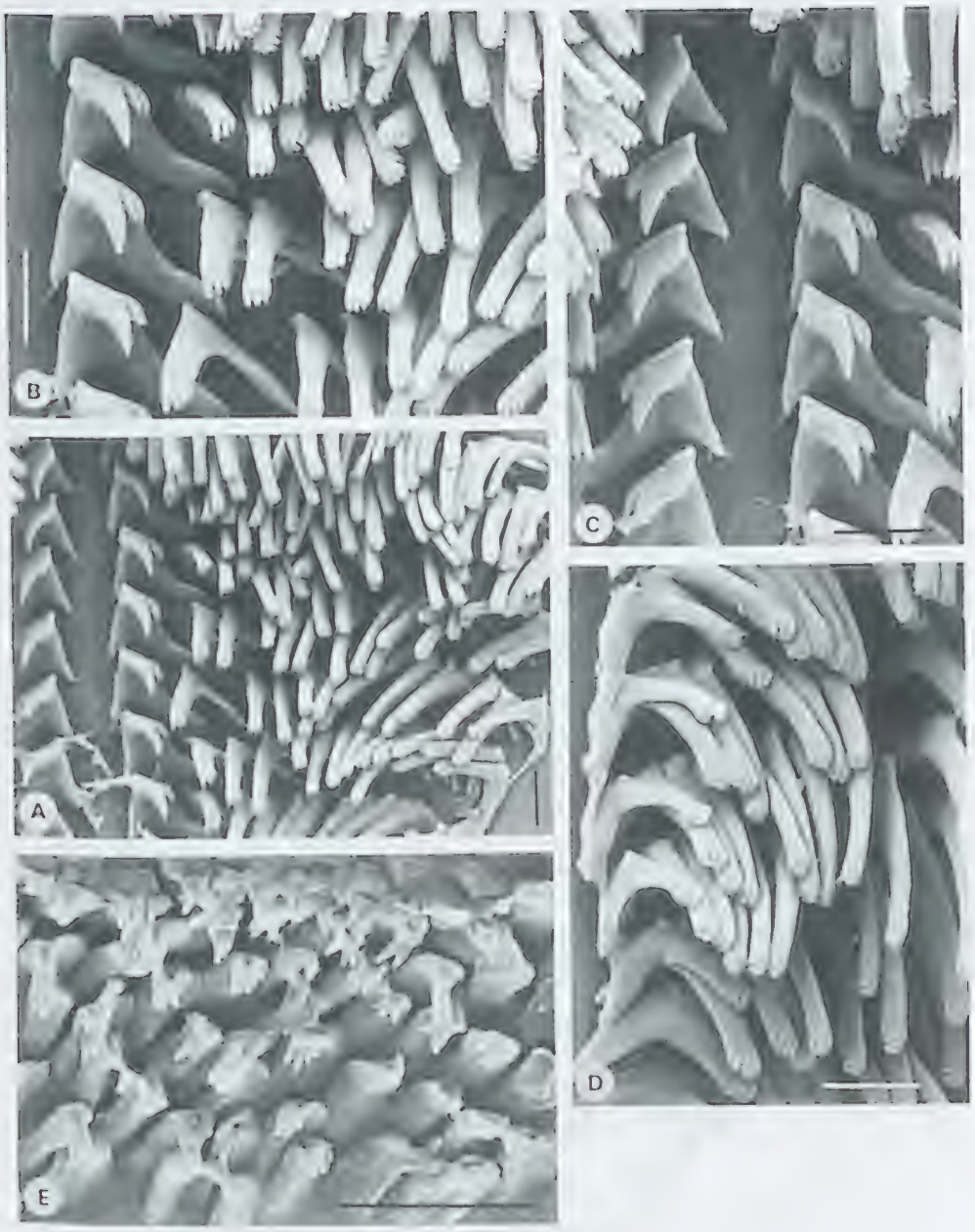

Figure 18. *Noumea verconiforma* sp. nov., Récif de l'Infernet, off Koumac, New Caledonia, 6 mm long alive, (AM C200499), scanning electron micrographs of radula and jaws. A, Section of radula showing central region and right side; B, Teeth 1–9 on right side; C, central region; D, outer teeth on left side; E, jaw rodlets. Scale = 20 μm in all cases. Photo: A.C. Miller.

sac. A narrow exogenous sperm duct leads from the junction of these two sperm sacs to the fertilisation chamber embedded on the female gland mass. The relatively long but unfolded muscular penial bulb is joined to the prostate gland by a short ejaculatory duct. The prostate gland is uncoiled and has only the one fold. No distinct vestibular gland was identified but it is possible that a small swelling at the genital opening is a homologue.

Remarks: The red-tipped gills and rhinophores and vibratile gills are reminiscent of *Noumea romeri* Risbec, 1928 (Rudman, 1984), but the spongiform texture of the mantle of this species is quite different. This species differs from both *Noumea romeri* and *Noumea simplex* (Pease, 1871) in the morphology of the radular teeth (Rudman, 1984). The lateral teeth of *N. verconiforma*, so similar to those of species of *Digidentis* Rudman, (1984, 1987), are quite different from the elongate lateral teeth of the other two species. A comparison with similarly coloured species is included under a discussion on the '*Noumea romeri* colour group' later in this paper.

The name '*verconiforma*' is a reference to the sponge-like coloration and texture of the mantle, reminiscent of *Verconia verconis* (Basedow & Hedley, 1905; Rudman, 1984).

Durvilledoris albofimbria n.sp.

(Figs 6F, 19–21)

Material: Channel, Passe de Koumac, 20°40.7'S, 164°14.7'E, 66–87m, dredged in mixed shell sand and mud, NW New Caledonia, HOLOTYPE, 11mm long alive, 24 October 1993, AM C200617 (in MNHN, Paris).

Description:

Colour: (Fig. 19) The mantle is translucent pink, with a deeper pink arc around the anterior end. The edge of the mantle is translucent clear, but just inside is a narrow band of bright opaque white. Visible through the transparency of the mantle edge are a row of translucent whitish spherical mantle glands. The body and foot are translucent

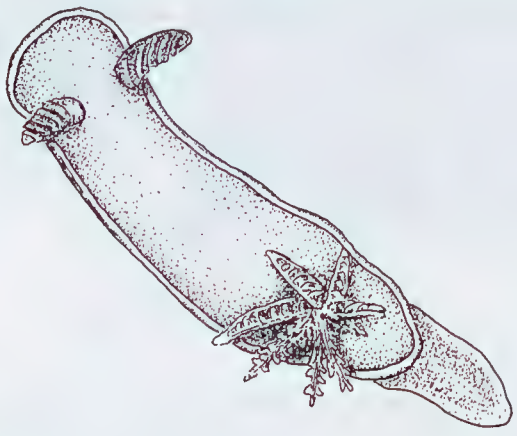

Figure 19. *Durvilledoris albofimbria* sp. nov., Passe de Koumac, New Caledonia, 11 mm long alive, (AM C200617).

pink, with a slightly purple tinge at the posterior end. There is a broad translucent clear band around the edge of the foot.

The rhinophore stalk is translucent with a distinct orange tinge. The rhinophore club is also translucent clear in the basal half, but in the upper half the core is opaque white. The lamellae are tinged with orange giving the whole rhinophore a watery orange coloration. The gills are also translucent clear but they are edged with a washy orange line.

Shape: (Figs 19, 20B) The mantle is elongately ovate, with a distinct but not greatly developed or folded mantle skirt. The mantle glands consist of single spheres arranged around the mantle edge. They are quite closely packed and around the anterior and posterior ends they become larger and more closely packed. There are seven simple gills forming an arch around the anal papilla. The gills are not vibratile.

Buccal armature: (Figs 6F, 21) The oral tube is much larger than the buccal bulb, at least 4–5 times as long. The radular formula of the holotype, 11mm long alive, is 18.0.18 x 35. All teeth, except for the outermost few, are of similar size and height, but become more slender towards the outside. The innermost lateral tooth on each side (Tooth 1), is tricuspid with two large pointed cusps at the tip, and a smaller inner one of about half the size of the others. Of the two large cusps, the outermost is slightly larger. The other lateral teeth, except for the outermost few, are bicuspid with a pair of long bluntly pointed cusps, the innermost cusp usually being smaller. The outermost three or four teeth are reduced in size, much shorter and have up to five terminal denticles.

The jaw rodlets appear to be large, pointed and unicuspid, but are often clustered in rows of three or four.

Reproductive system: (Fig. 20A) The vaginal duct is relatively broad and straight and

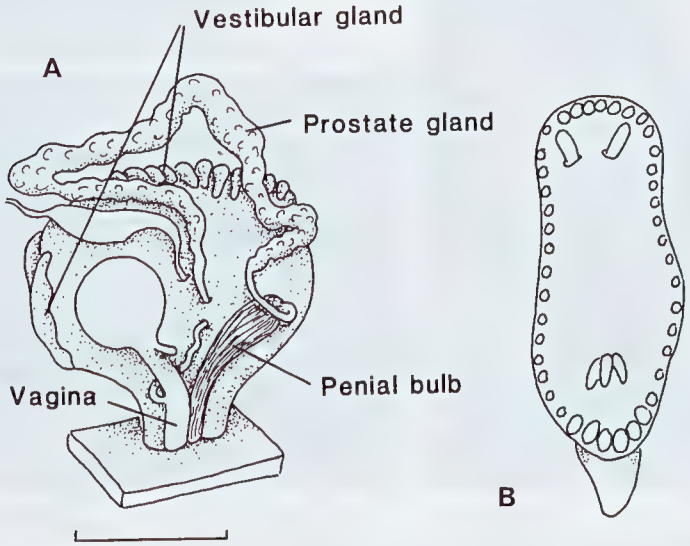

Figure 20. *Durvilledoris albofimbriae* sp. nov., Passe de Koumac, New Caledonia, 11 mm long alive, (AM C200617). A, Reproductive system (scale = 1mm); B, whole animal showing arrangement of mantle glands.

leads back to the large spherical gametolytic sac. A very small exogenous sperm sac opens off the vaginal duct near its junction with the gametolytic sac. The exogenous sperm duct branches from the vagina about a third of the distance from the genital opening. The muscular penial bulb is of similar length to the vagina. It gradually increases in diameter posteriorly. A short ejaculatory duct connects the penis to the prostate gland, which although slightly folded, is relatively short for the family. It lies over the female gland mass, running from one side to the other before folding back to

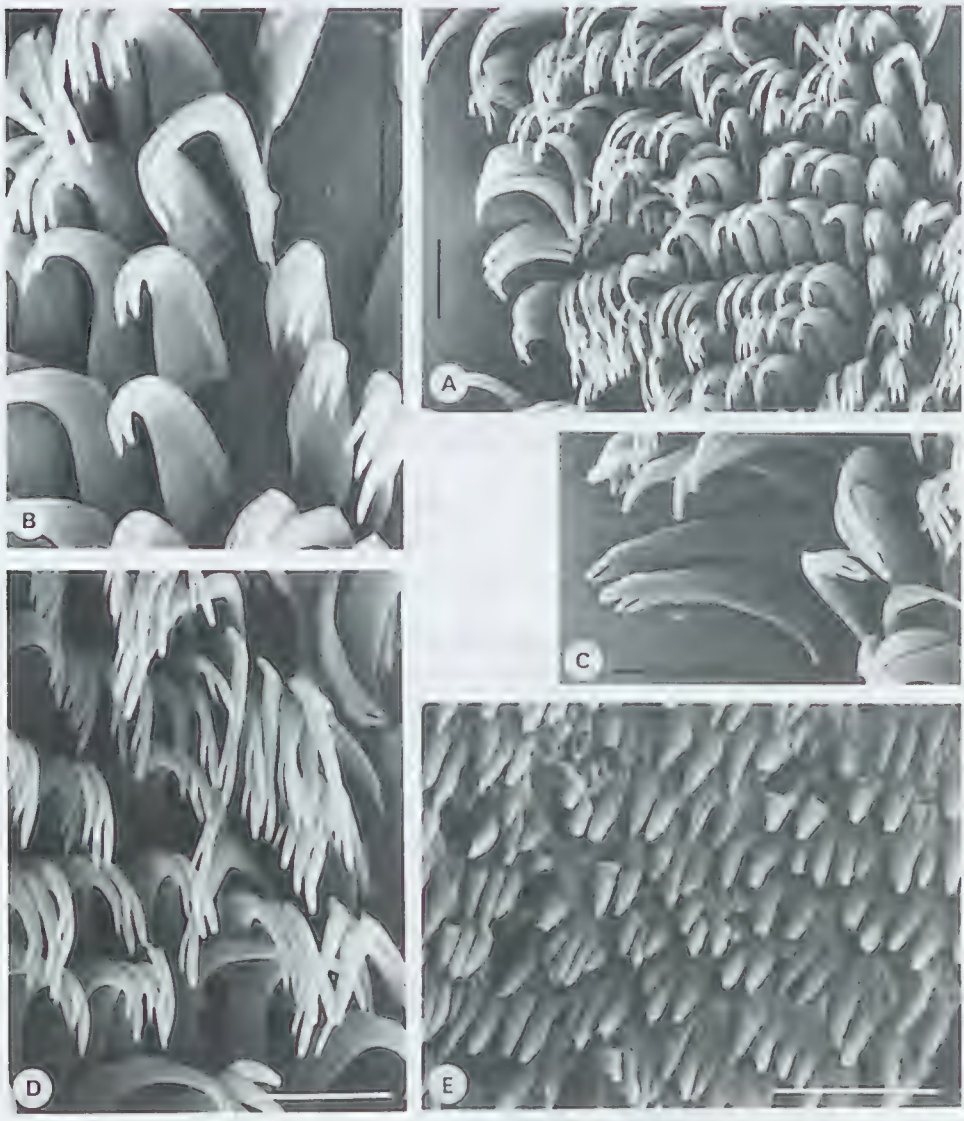

Figure 21. *Durvilledoris albofimbriae* sp. nov., Passe de Koumac, New Caledonia, 11 mm long alive, (AM C200617), scanning electron micrographs of radula and jaw plates. A, Section of radula showing central region and left side; B, central region showing innermost right and left lateral teeth; C, outermost left lateral teeth; D, mid-lateral teeth on left side; E, jaw rodlets. A–D, scale = 20 μm; E, scale = 10 μm. Photo: A.C. Miller.

run down to the female gland mass, where it joins with the spermoviduct.

The vestibular gland forms a thin layer of finger-like ducts over the ventral surface of the female gland mass.

Remarks: The anatomy of this species has similarities to species of *Thorunna* and *Durvilledoris* (Rudman, 1984, 1986b, 1990). Species of both genera have a very similar reproductive system characterised in part by an elongate vagina and a relatively large exogenous sperm sac. *Durvilledoris albofimbria* differs in having a relatively short vagina and a very small exogenous sperm sac. The radular morphology also has similarities to both genera, the bifid lateral teeth resembling those of *Thorunna*, but the multicuspid innermost teeth and the well-developed jaw plates are reminiscent of *Durvilledoris*. The relative proportions of the oral tube and buccal bulb are also more characteristic of *Durvilledoris*. The presence of spherical glands packed in a row around the mantle edge is also characteristic of *Durvilledoris*. Unlike species of *Thorunna*, this species does not rhythmically wave its gills.

This species is almost identical in colour to *Hypselodoris punicea* and both species were found at the same locality.

The main external difference is that in that species the gills rhythmically wave, while in *Durvilledoris albofimbria* they do not. There are of course major anatomical differences. Both these species are compared later in this paper under a comparison of the *Noumea romeri* colour group.

The name '*albofimbria*' refers to the white edge or fringe to the mantle skirt, 'fimbriae' being Latin for the fringe of a dress.

Hypselodoris punicea n.sp.
(Figs 6J, 22, 23, 24A)

Material: Channel, Passe de Koumac, 20°40.7'S, 164°14.7'E, 66–87m, dredged in mixed shell sand and mud, NW New Caledonia, HOLOTYPE, 12mm long alive, 24 October 1993, AM C200618 (in MNHN, Paris).

Description:

Colour: (Fig. 22) The mantle is a bluish purple with a pinkish tinge anteriorly, between the rhinophores. There is a thin opaque white line right at the mantle edge. The rhinophore stalk is wine-red, the colour diffusing on to the basal part of the club. The rest of the rhinophore club is yellow except for the upper few lamellae which are purplish red. The knob at the tip of the rhinophore is translucent clear.

The simple gills are translucent clear with a yellowish tinge. Their outer edge is orange on the basal half, and red on the upper half. The red coloration is found right along the inner edge of each gill. The change from orange to red along the outer edge is very diffuse.

The foot and underside of the body is a uniform bluish purple, somewhat darker than that of the mantle.

Shape: (Fig. 22) The mantle is elongately oval somewhat broader anteriorly, giving the body a spatula-like shape. The body is relatively high and the mantle overlap not greatly developed into a skirt. It has similarities in shape to species of *Hypselodoris*

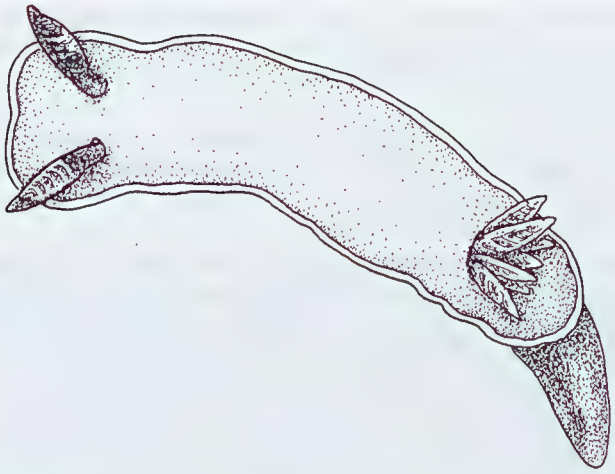

Figure 22. *Hypselodoris punicea* sp. nov., Passe de Koumac, New Caledonia, 12mm long alive, (AM C200618).

and *Risbecia* Odhner, 1934 (Rudman, 1984). There are eight simple gills arranged in a circlet, open posteriorly, around the anus. The two most posterior gills are smaller than the others. The gills vibrate rhythmically as the animal crawls along.

There were no clear signs of mantle glands in either the living or preserved specimen.

Buccal armature: (Figs 6J, 23) The oral tube and buccal bulb are similar in length, the oral tube probably slightly smaller, and the radular sac can be seen projecting slightly posteriorly. The radular formula of the holotype, 12mm long alive, is 36.0.36 x 38. All but the outermost few teeth are similar in size and shape. The innermost tooth in each row has a rather parallel-sided shaft surmounted by a pair of large recurved cusps. The larger of these is bluntly pointed while the smaller outer cusp is more sharply pointed. On the base of the larger inner cusp is a small pointed denticle giving the tooth a tricuspid shape. Tooth 2 is similar in shape to Tooth 1 but lacks the inner denticle. From Tooth 2 all the teeth are bicuspid. They are all of similar size and shape until the outer three or four which gradually decrease in size, the outermost being only about half the normal size. There are no sign of outer denticles on any of the lateral teeth.

The jaw rodlets are broad flattened and unicuspid, although a few are split to form bicuspid pairs.

Reproductive system: (Fig. 24A) The elongate vaginal duct is thin and somewhat folded and leads to a large spherical gametolytic sac and smaller elongate exogenous sperm sac. The exogenous sperm duct branches off the vaginal duct near its junction with the sperm sacs and runs directly to the fertilisation chamber in the female gland mass. The penial bulb is long and folded leading back to a broadened posterior region where the narrow ejaculatory duct (vas deferens) enters. The tubular prostate gland is somewhat folded and lies over the female gland mass. The vestibular gland is a thin layer of tubular ducts which lie over the ventral surface of the female gland mass.

Remarks: In shape, apart from being much smaller, this species is reminiscent of species of *Hypselodoris* and *Risbecia*. The radular morphology is also similar to that

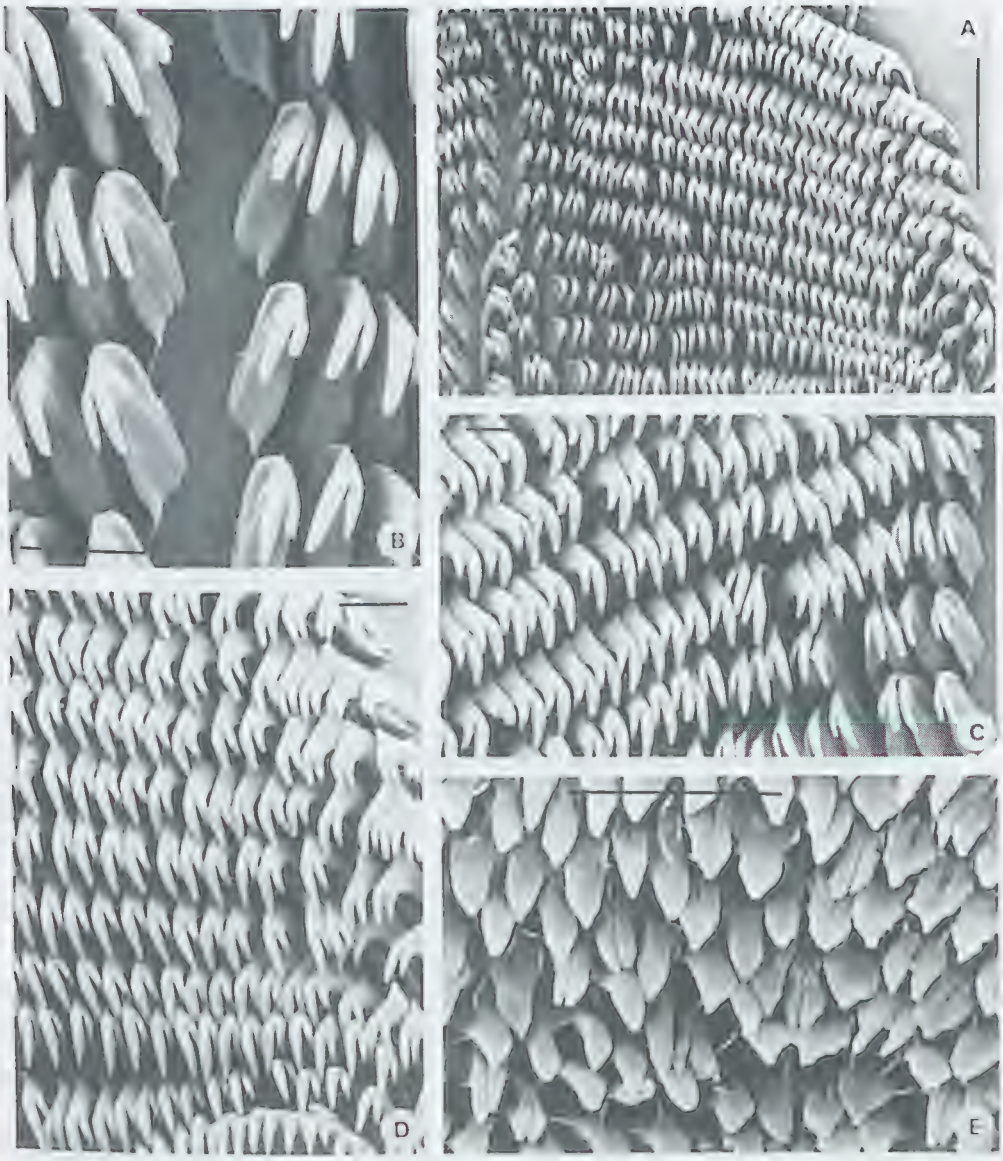

Figure 23. *Hypselodoris punicea* sp. nov., Passe de Koumac, New Caledonia, 12mm long alive, (AM C200618), scanning electron micrographs of radula and jaws. A, section of radula showing central region and right side; B, central region; C, Teeth 1–21 on left side; D, outer half of right side of radula; E, jaw rodlets. A, scale = 100 µm; B–E, scale = 25 µm. Photo: A.C. Miller.

group (cf *H. mouaci*, *R. tryoni*: Rudman, 1984, Figs 54, 63), but differs in lacking any outer denticulation. The reproductive system however is quite different from those species, being very similar to that of species of *Durvilledoris* and *Thorunna*. The vibratile gills are also characteristic of *Thorunna*, as is the apparent absence of mantle glands. However the foregut anatomy and buccal armature make any relationship with *Thorunna* most unlikely, unless it is to be considered a most 'primitive' member of the group linking the genus with *Hypselodoris* and *Risbecia*.

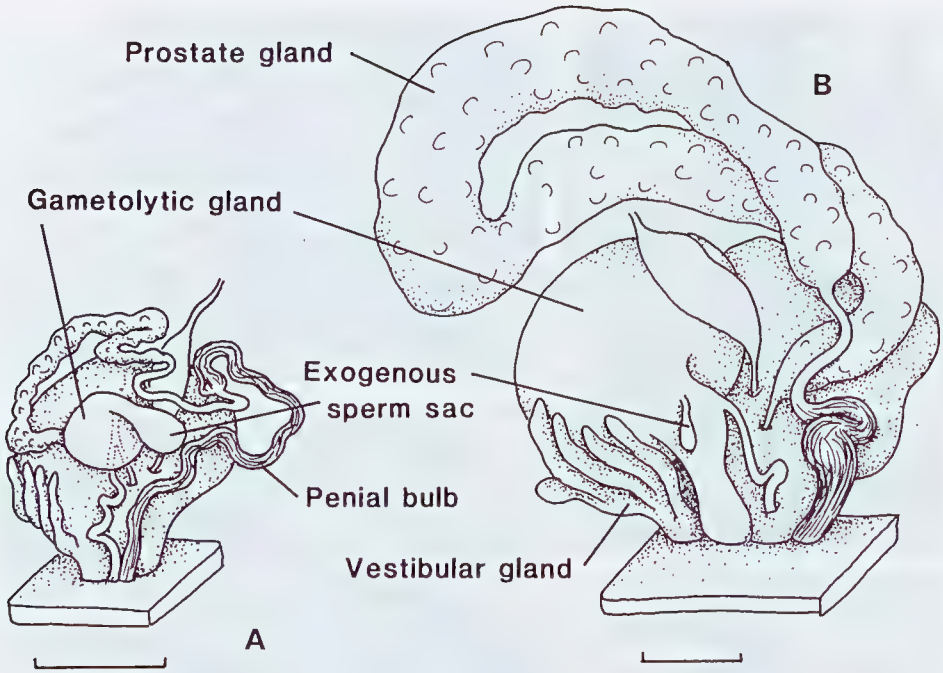

Figure 24. Reproductive system. A, *Hypselodoris punicea* sp. nov., (AM C200618), scale = 1 mm; B, *Hypselodoris koumacensis* sp. nov., (Holotype), scale = 2 mm.

In colour this species is almost identical to *Chromodoris rosans* Bergh, 1889, which from his anatomical description is most probably a species of *Hypselodoris*. It was described as being translucent pink with a white border, and yellow rhinophores lined in red. The gills were yellow with red at the tip, and the dorsal posterior part of the foot was bluish-red. It was recorded from Mauritius. From Bergh's description the vagina is relatively wide and muscular with a large spherical gametolytic sac, but no evident exogenous sperm sac. The apparent absence of the exogenous sperm sac suggests the genus *Hypselodoris*, in which the sac can be extremely small. Although the teeth appear very denticulate, the illustrations suggest that the tips are bicuspid. Similarly, the unicuspid jaw rodlets are characteristic of the *Hypselodoris* group of genera. Despite these two species being most likely congeneric, *Hypselodoris puniceus* varies in the nature of the reproductive system, (with a narrow folded vaginal duct and relatively large exogenous sperm sac), and the non-denticulate radular teeth, which have a pair of prominent terminal cusps. Other similarly coloured species are discussed later in this paper, as the *Noumea romeri* colour group.

The name '*punicea*' from the Latin for pink, is a reference to the colour of the mantle.

Hypselodoris lacteola n.sp.

(Figs 25B, 26)

Material: (1) S Lagoon, east entrance to Canal Woodin, New Caledonia, 36m, 30 July

1987, MG294, 2 specimens (11, 12 mm long preserved), coll: P.Laboute, HOLOTYPE (11 mm long – AM C303255 in MNHN, Paris); PARATYPE (12 mm long – AM C167919 in AM). (2) Banc Gail, between Noumea and Ile Ouen, S Lagoon, New Caledonia, 30m, 25 May 1988, (MG294) 1 specimen, coll: P. Laboute, (specimen lost).

Description:

Colour: (Fig. 25B) The mantle is white with purplish red gills and rhinophores. There is a tinge of reddish purple on the posterior tip of the foot. The rhinophore stalk is purplish red and the anterior and posterior edges of the rhinophore club and the lamellae are the same colour. There is a background core of white in the rhinophore club. There are six simple gills. They are translucent white with purplish red edges.

Shape: (Fig. 25B) The mantle is elongately ovate, with the anterior end being slightly wider, giving the body a spatula-like shape. The body is relatively high and the mantle overlap is not greatly developed. The gills are simple, and the position of the gills in one photograph suggest that they are probably vibratile.

Buccal armature: (Fig. 26) The radular formula of a specimen 12mm long preserved, is 30.0.30 x 41. The bicuspid teeth are all very similar in shape and size except for the innermost lateral tooth which has a small inner denticle at the base of the inner cusp. The teeth have a broad shaft which recurves to terminate in a pair of long pointed cusps. The jaw rodlets are unicuspid.

Reproductive system: The two specimens available had dried at some stage in their storage and were too damaged to allow a study of the reproductive system.

Remarks: The body shape and radular morphology of *Hypselodoris lacteola* sp.nov. is very similar to that of *H. puniceus* sp. nov. Although many species of chromodorid have a predominantly white mantle (Rudman, 1985, 1986a, 1990), in most cases it is combined with a coloured border. *Hypselodoris lacteola* and *Glossodoris*

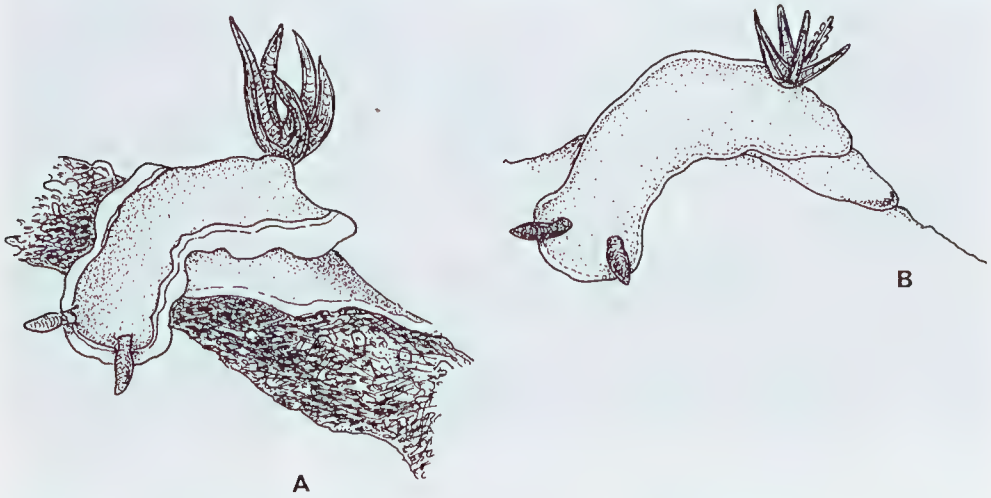

Figure 25. A, *Hypselodoris flavomarginata* sp. nov., Banc Gail, SW Lagoon, New Caledonia, 25 mm long preserved (AM C168011); B, *Hypselodoris lacteola* sp. nov., Canal Woodin, New Caledonia, 11 mm long preserved (Holotype, AM C303255).

misakinosibigae Baba, 1988 are unique in not having a coloured border or coloured spots.

The name, '*lacteola*' is from the Latin for milky-white, a reference to the colour of this species.

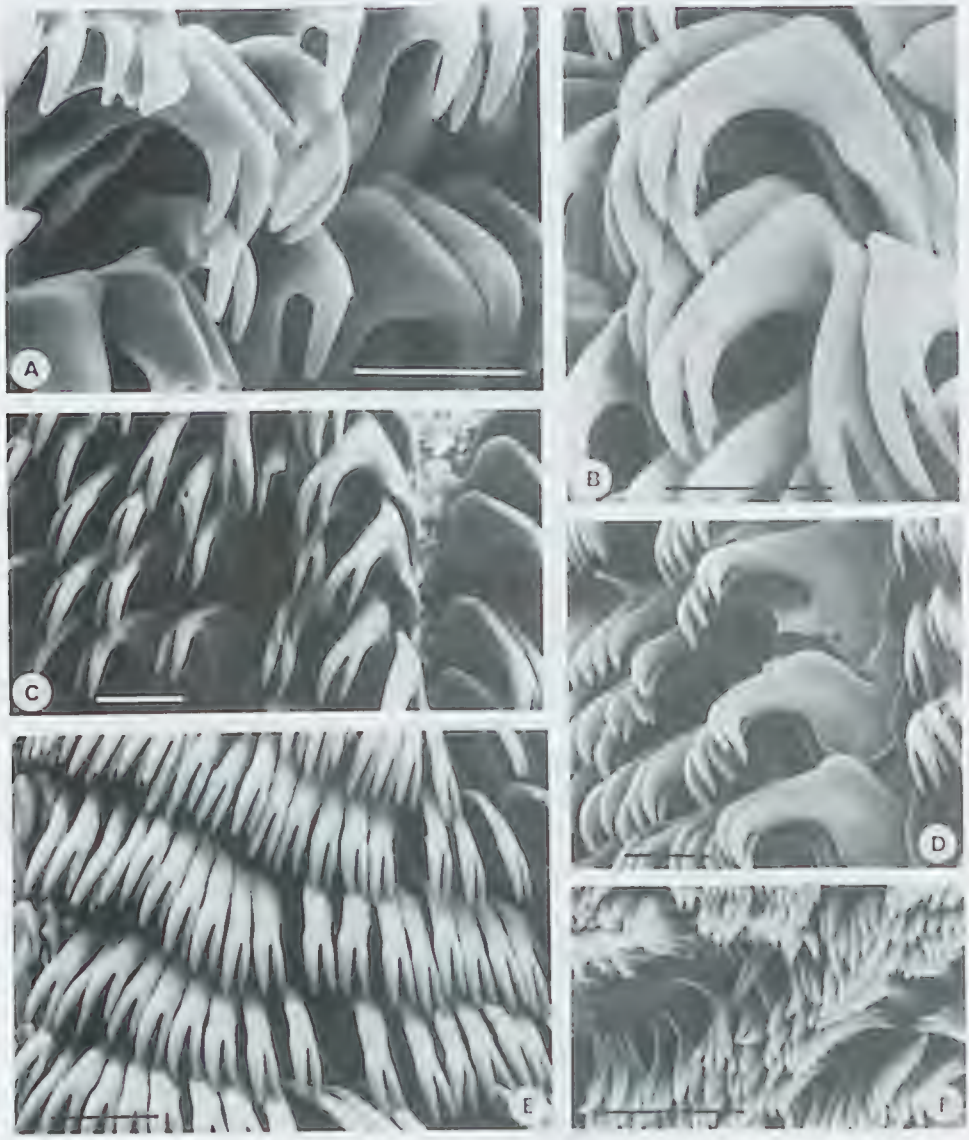

Figure 26. *Hypselodoris lacteola* sp. nov., Canal Woodin, New Caledonia, 12mm long preserved, (AM C167919), scanning electron micrographs of radula and jaws. A, central region showing innermost right and left lateral teeth; B, inner right lateral teeth; C, inner lateral teeth on left side; D, inside of mid-laterals on left side; E, mid-lateral teeth on left side; F, jaw rodlets. Scale = 20 μm in all cases. Photo: A.C. Miller.

Hypselodoris flavomarginata n.sp.
(Figs 6H, 25A, 27, 28, 29)

Noumea romeri: Laboute, Feuga & Grandperrin, 1991: 181 (misidentification).

Material: All specimens are from New Caledonia. (1) Grande Coude, Bourail, W Coast, 15m, 1 October 1988, 15mm long, coll: L. Faucompré, (F 097), HOLOTYPE, AM C168012 (in MHNH, Paris). (2) 5 Mile Channel, between Récifs U & Niagi, SW Lagoon, 35m, 14 April 1982, 14mm long preserved, on sponge 1334, MG244, PARATYPE, (in MNHN, Paris). (3) Banc Gail, SW Lagoon, between Noumea and Ile Ouen, 30m, 28 March 1988, MG244 (Photo only); 33m, 26 April 1990, 2 specimens on sponge, 16, 25 mm long preserved, MG244, PARATYPE, AM C168011, with sponge, (in AM).

Figure 27. *Hypselodoris flavomarginata* sp. nov., Chenal de 5 miles, New Caledonia, April 1982, scanning electron micrographs of radula. A, section of radula showing central region and right side; B, outermost right lateral teeth; C, central region; D, inside of innermost right lateral teeth; E, mid-lateral teeth from right side. A, scale = 100 µm; B–E, scale = 30 µm. Photo: A.C. Miller.

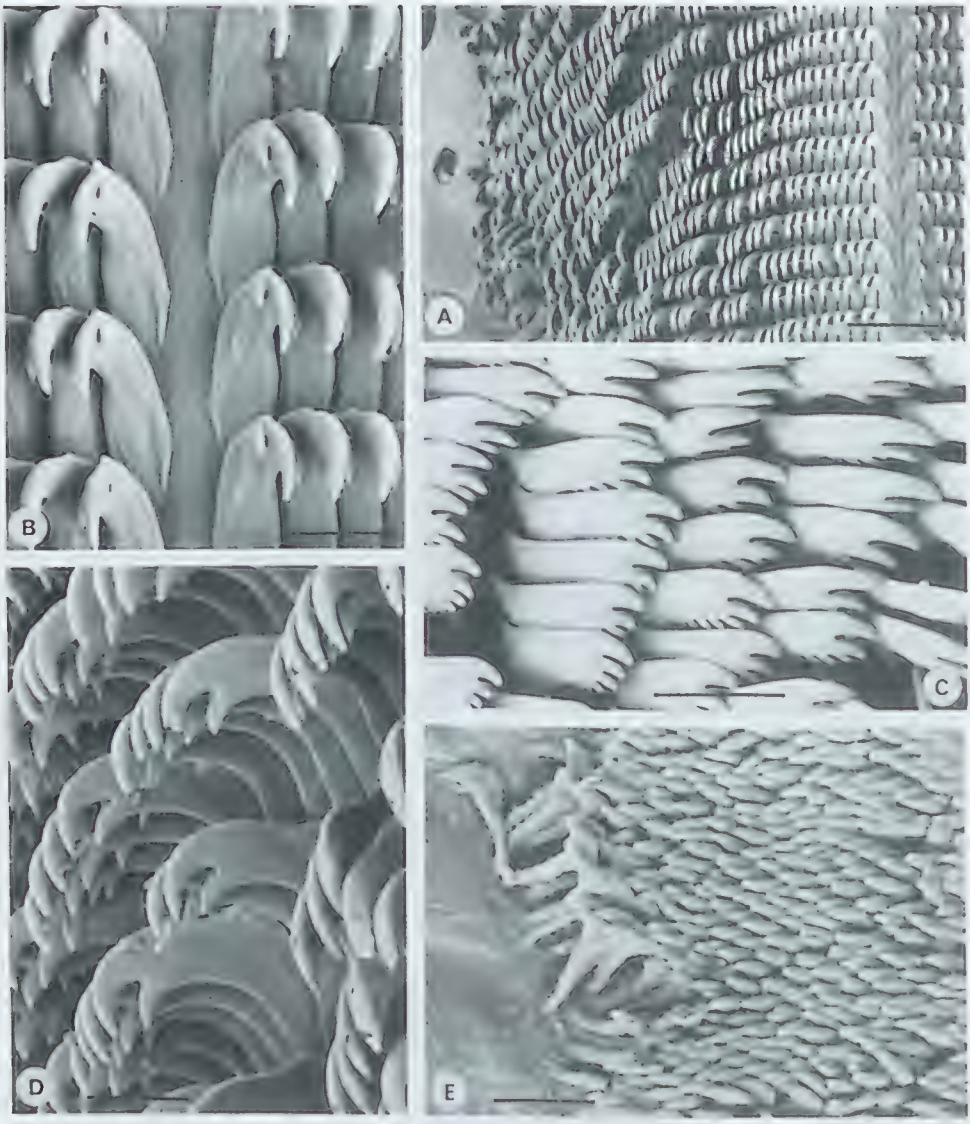

Figure 28. *Hypselodoris flavomarginata* sp. nov., Banc Gail, New Caledonia, (AM C168011), scanning electron micrographs of radula and jaws. A, Section of radula showing central region and left side; B, central region; C, outside of mid-lateral teeth; D, inside of inner laterals; E, jaw rodlets. A, scale = 100 μm; B–E, scale = 25 μm. Photo: A.C. Miller.

Description:

Colour: (Fig. 25A) The mantle is bright pink with a broad yellow or cream band at the edge. Between the yellow border and the pink, there is a thin opaque white line. The rhinophore stalk is purple-red and the club has a translucent white core but the anterior and posterior edges, and the lamellae, are translucent purplish red. The simple gills are translucent clear but edged in purplish red. The underside is a translucent

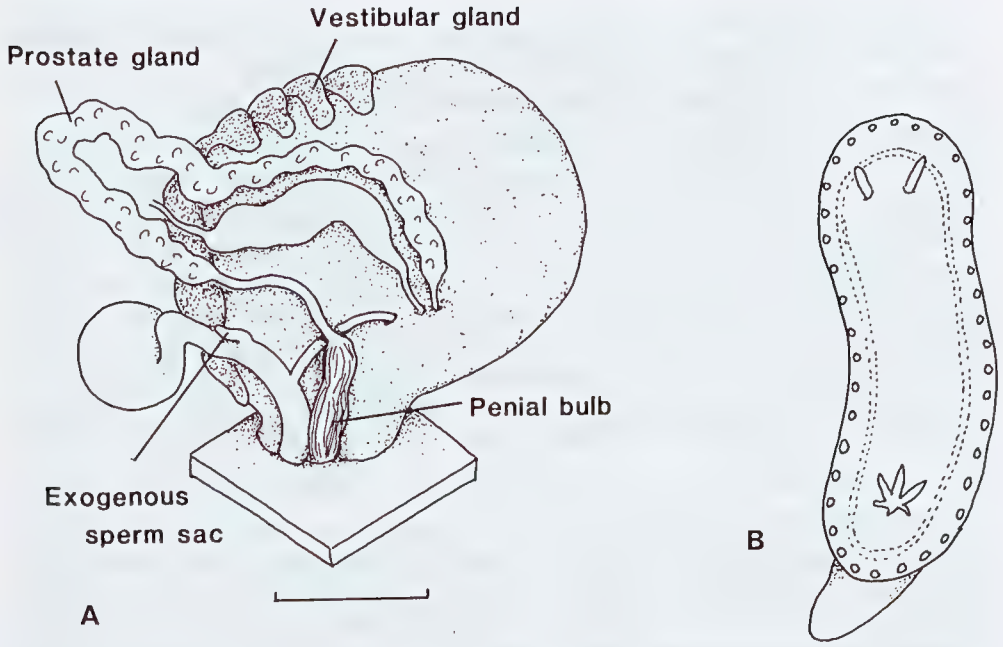

Figure 29. *Hypselodoris flavomarginata* sp. nov., Banc Gail, New Caledonia, (AM C168011). A, Reproductive system, (scale = 2 mm); B, whole animal showing arrangement of mantle glands.

creamy white except for the visible posterior part of the foot which is a similar pink to the mantle.

Shape: (Figs 25A, 29B) The mantle is elongately ovate with the posterior part of the foot exposed when the animal is crawling. In profile the body is relatively high, the highest point being the gill pocket, about two-thirds of the way down the body. The five simple gills form a circle around the anus and are held vertically. In one preserved specimen (5 Mile Channel) a row of small single mantle glands can be seen right at the mantle edge. They are all of similar size with no noticeable crowding or enlarging around the posterior end.

Buccal armature: (Figs 6H, 27, 28) The oral tube and buccal bulb are of similar length, and only a small terminal part of the radular sac protrudes out of the buccal bulb in the posterior midline. The radular formula of a specimen 25mm long preserved (C168011) is 44.0.44 x 73, and of a 14mm preserved specimen (5 Mile Channel), 34.0.34 x 51. The broad and recurved first lateral tooth on each side (Tooth 1) is essentially tricuspid, with a large pointed central cusp and a slightly smaller outer one. At the base of the central cusp, on the inside, is a small pointed cusp. Tooth 2 to 15 are of similar size and shape to Tooth 1 but they lack the small inner cusp. On Tooth 15 a small outer denticle appears and from Tooth 15 to Tooth 20 the shape of the teeth begins to change with the cusps becoming smaller, although the blade remains of similar length. By Tooth 21 the cusps have become relatively small, the outer being considerably smaller than the inner, and there are up to six outer denticles. The outer five or six teeth are reduced in size and the two cusps are indistinguishable in size and shape from the two

or three remaining denticles. They are all short rounded and digitiform, forming a comb at the tip and down the upper and outer edge of each tooth.

The jaw rodlets have a large recurved unicuspid tip.

Reproductive system: (Fig. 29A) The vaginal duct is relatively broad and straight, leading back to the large spherical gametolytic sac. The exogenous sperm sac which opens into the vagina about two-thirds of the way back, is extremely small, and lies folded upwards along the vaginal wall. The exogenous sperm duct branches from the vagina about one-third of the way back from the genital opening and runs to the fertilisation chamber within the female gland mass. The muscular penial bulb is short, less than half the length of the vagina, and is joined to the tubular prostate gland by a short muscular vas deferens. The prostate gland lies folded over the female gland mass and partly obscures the gametolytic sac. The vestibular gland is a thin layer of tubular ducts covering much of the underside of the female gland mass.

Remarks: A good colour illustration of this species has recently been published (Laboute, Feuga & Grandperrin, 1991). The buccal armature and reproductive system are typical of the genus *Hypselodoris*. The colour pattern is very characteristic, differing from all other pink chromodorids in the presence of the broad outer cream or yellow border and an narrow inner line of opaque white. It has similarities to the colour of *Thorunna speciosus* Rudman, 1990, which was originally described as having a pinkish purple mantle with a yellow border overlying a band of opaque white. Further material of *T. speciosus*, now available to me, show that it can range in colour to a distinct pink with a broad yellow cream border with the underlying white forming a distinct thin white band on the inside edge of the cream. Thus in colour it is very similar to *Hypselodoris flavomarginata*. The internal anatomy however is quite different.

The name '*flavomaculata*' is a reference to the yellow band bordering the mantle.

Hypselodoris koumacensis n.sp.

(Figs 6C, 24B, 30, 31)

Material: Grande Récif de Koumac, N Lagoon, New Caledonia, (st 292) 45m, HOLOTYPE, 32mm long preserved, 3 November 1980, MG222, (MNHN, Paris).

Description:

Colour: (Fig. 30) The mantle is a creamy white with a pair of irregular orange brown lines which loop around the back of the gill pocket to join in the posterior midline and anteriorly pass between the rhinophore pockets before joining in an anterior loop. In the anterior loop, part of the brown line is replaced with reddish purple. There is a triple band around the mantle edge. At the extreme edge is a broken band of translucent watery purple. Inside this there is a broader opaque yellow-orange band. Around the inner edge of the yellow-orange band is a string of elongate reddish purple patches. These patches are usually joined by a thin line of the same colour, but around the anterior end they are not. Posteriorly there are traces of a second brown line on each side running around the gill pocket just in from the mantle edge. The rhinophore stalk

Figure 30. *Hypselodoris koumacensis* sp. nov., Koumac, New Caledonia, 32 mm long preserved, (Holotype).

and club are orange-yellow with a darker brownish line along the posterior midline of the club. The gills are translucent white with an orange-brown line along the outer and inner edges. The colour of the upper half of the inner edge has traces of reddish-purple.

The body and foot are of similar colour to the mantle, cream with some longitudinal brown lines, and an inner reddish purple and outer orange-yellow border.

Shape: (Fig. 30) The body is relatively high with a narrow mantle overlap. The mantle is broadest anteriorly where it forms a wide rounded flap giving the body a spatula-like shape. The eight simple gills form a circle around the anus and sit vertically forming a raised goblet-like cluster. The mantle glands are clearly visible in the preserved specimen. They are single spherical glands and lie at the mantle edge running from the level of the rhinophores posteriorly. Along the sides of the mantle they are regularly spaced, separated by approximately their own diameter. Around the posterior end however they are larger and packed closely together.

Buccal armature: (Figs 6C, 31) The oral tube and buccal bulb are of similar lengths. The radular sac projects from the postero-ventral midline of the buccal bulb a considerable distance. The radular formula of the holotype, 32mm long preserved, is 98.0.98 x 65. All the teeth, except for the outer few are of similar size. The innermost lateral tooth on each side has a recurved tricuspid blade. The innermost cusp is relatively short and straight, approximately half the length of the other two, which are slightly curved. Of these two cusps, the outer is somewhat longer. Tooth 2 is very similar in shape to Tooth 1 except it lacks the small inner cusp. No outer denticles are present. From Tooth 2–60 the teeth are all of similar shape and size although the cusps become progressively longer. From Tooth 60 the whole tooth begins to gradually diminish in size and the cusps become shorter. From approximately Tooth 80 the outer of the two cusps becomes relatively straight and slightly shorter than the curved inner cusp. At approximately Tooth 90, one small outer denticle appears on the outer edge of the blade, and within two or three teeth there are four or five outer denticles. The outer two or three teeth are reduced to triangular plates.

The jaw rodlets are unicuspid.

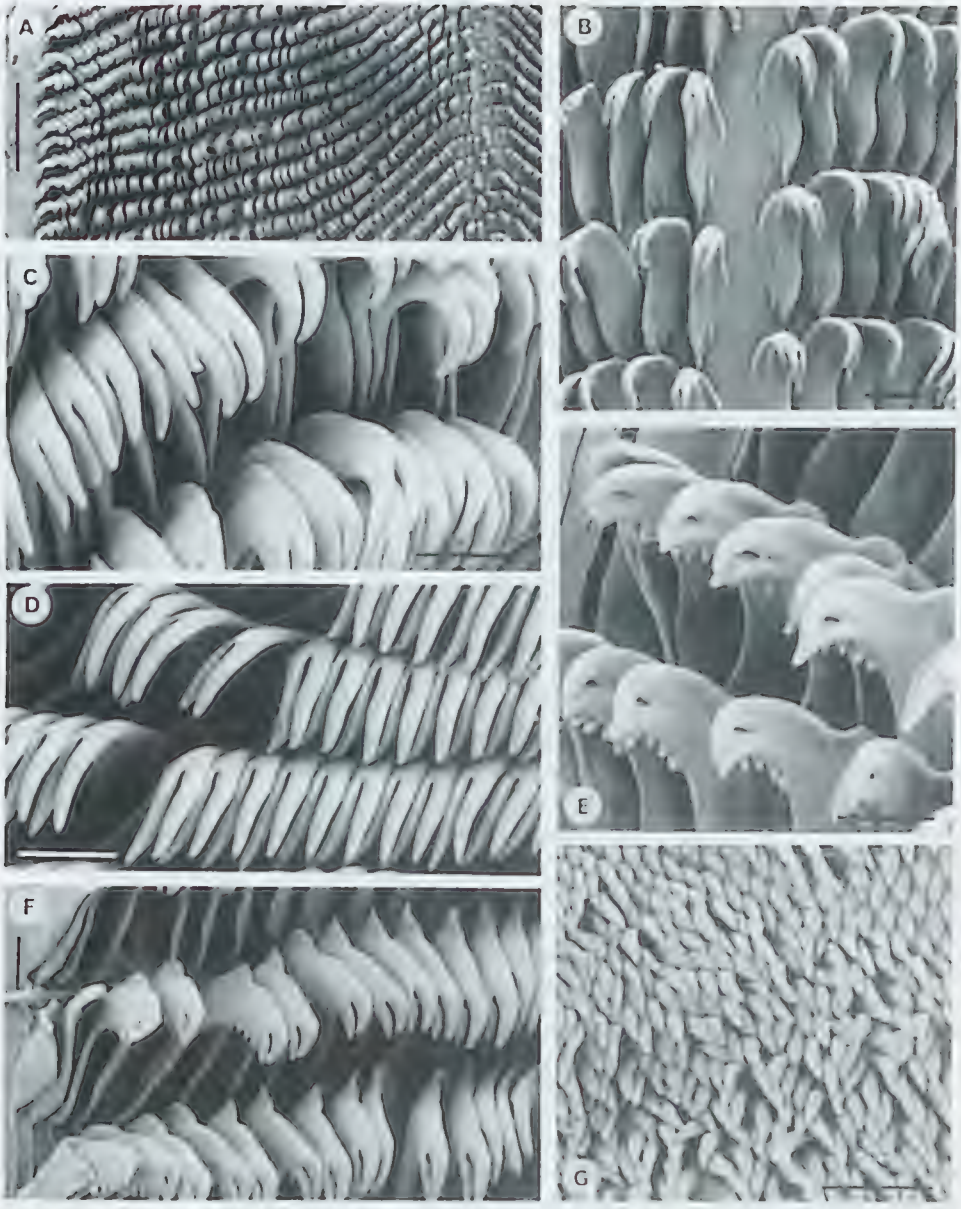

Figure 31. *Hypselodoris koumacensis* sp. nov., Koumac, New Caledonia, 32 mm long preserved, (Holotype), scanning electron micrographs of radula and jaws. A, Section of radula showing central region and left side; B, central region; C, inner laterals on left side; D, mid-laterals on left side; E, inside of outermost left laterals, F, outermost left laterals; G, jaw rodlets. A, scale = 200 μm; B–G, scale = 20 μm. Photo: A.C. Miller.

Reproductive system: (Fig. 24B) The short muscular vagina leads to a large spherical gametolytic sac. The exogenous sperm sac is reduced to a minute diverticulum off the vagina near its opening into the gametolytic sac. The exogenous sperm duct opens from the vagina opposite the exogenous sperm sac opening. This duct is relatively long

and folded and runs to the fertilisation chamber in the female gland mass. The penial sac is slightly longer than the vagina and joins to the large prostate gland by a short muscular vas deferens. The vestibular gland consists of a layer of tubular glands lying along the side and ventral surface of the female gland mass.

Remarks: This species belongs to a group of species with a relatively high body, narrow mantle overlap and which hold their gills in an upright cluster. It is characterised by the longitudinal orange-brown lines and orange and purple mantle border. The reproductive system and buccal armature are characteristic of the genus *Hypselodoris*. The name '*koumacensis*' refers to Koumac in north-western New Caledonia, where this specimen was collected, and where very valuable collections of opisthobranchs were made during the Montrouzier Expedition (October and November 1993).

Thorunna montrouzieri n.sp.

(Figs 6G, 32, 33, 34)

Material: Passe de Koumac, east face, 20°40.4'S, 164°14.9'E, 26–40m, loose rubble on sand, 28 October 1993, 2 specimens, HOLOTYPE, 14mm long alive, AM C200701 (in MNHN, Paris); PARATYPE, 8mm long alive, AM C303256 (in AM).

Description:

Colour: (Fig. 32) There is a broad white band down the centre of the mantle from in front of the rhinophores to behind the gills. Across the anterior end of the mantle is a rounded patch of orange red, flanked by a band of purple on each side which run back to just behind the rhinophores. Behind the purple is a broad orange band which runs down each side to just behind the level of the gills. Another band of purple runs around

Figure 32. *Thorunna montrouzieri* sp. nov., Passe de Koumac, New Caledonia, 2 specimens; Left, Holotype, 14 mm long alive, (AM C200701); Right, Paratype, 8 mm long alive, (AM C303256).

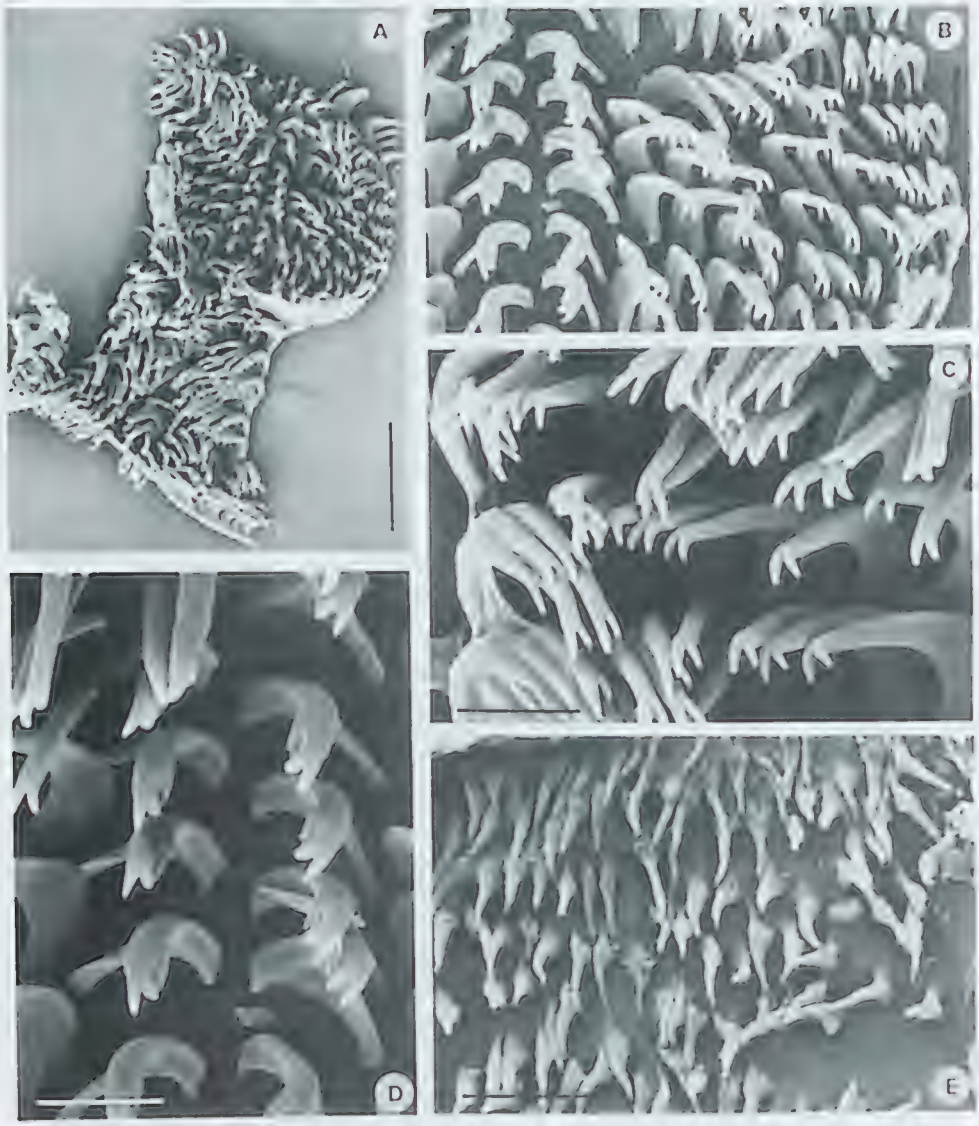

Figure 33. *Thorunna montrouzieri* sp. nov., Passe de Koumac, New Caledonia, 14 mm long alive, (AM C200701), scanning electron micrographs of radula and jaws. A, whole radula; B, central region and right side of part of radula; C, right lateral teeth; D, central region; E, jaw rodlets. A, scale = 100 μm; B–E, scale = 20 μm. Photo: A.C. Miller.

the posterior end of the mantle. Except for the anterior orange red patch which runs right to the mantle edge, the rest of the mantle has a thin white band around the edge. This is particularly pronounced around the posterior end. The orange band down each side of the mantle has a thin red line along its inside edge which widens into rounded red patches extending into the white central band (two in the largest specimen, three in the smaller).

The rhinophore stalk is translucent white with orange patching. The rhinophore club

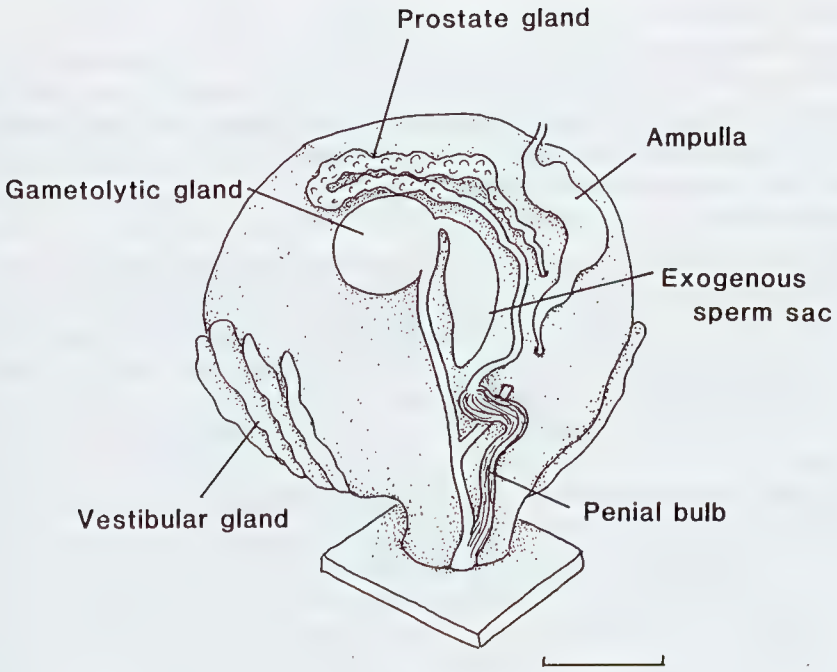

Figure 34. *Thorunna montrouzieri* sp. nov., (AM C200701), Reproductive system. Scale = 1 mm.

has a white core and the anterior and posterior edges, and the lamellae are bright orange red. The simple gills have an opaque white core with orange-red edges and lamellae. The underside of the mantle is opaque white while the body, head and foot are translucent purple except for the visible posterior portion of the foot which is white with a translucent purple border.

Shape: (Fig. 32) The mantle is elongately ovate, with a noticeable widening at the anterior end giving the animal a spatula-like shape. The foot extends posteriorly beyond the mantle when the animal is crawling. There is a relatively wide mantle overlap especially around the anterior end. The rhinophore club is very elongate and the rhinophore pockets are noticeably raised. The gills are simple and arranged in a circle around the anus. The gills vibrate rhythmically. Mantle glands were not clearly visible, but small projections at the mantle edge on each side suggest the presence of a few small single glands at the mantle edge. The opaque white band around the posterior end of the mantle also is suggestive of mantle glands. However in the preserved specimens glands could not be confirmed anywhere on the mantle.

Buccal armature: (Figs 6G, 33) The buccal bulb is proportionally very small, the oral tube being at least six times as long. In the specimen 14mm long alive, the radular formula is 12.1.0.1.12 x 26. The innermost lateral tooth on each side has a broad triangular base which rises to a recurved blade with a pair of small pointed terminal cusps and a smaller cusp or denticle down the inside edge. The other lateral teeth are similar in size but have a less triangular base and a more elongate blade. The outer terminal cusp is always slightly larger than the inner. The rodlets of the much reduced jaws have a broad conical base rising to a unicuspid tip.

Reproductive system: (Fig. 34) The vaginal duct is long and narrow and leads to the large spherical gametolytic sac and ovate exogenous sperm sac. Both sperm sacs are of similar size and have a common vaginal opening. The exogenous sperm duct branches from the vagina about one-third of the way from the opening. The penial bulb is long and broadens posteriorly. The thin muscular vas deferens leads from the penis to the tubular prostate gland which lies over the female gland mass and partly covers the gametolytic gland.

Remarks: The foregut and radular morphology, vibratile gills, and reproductive system are all characteristic of the genus *Thorunna*. Its coloration is quite unlike any described species of that genus. It has superficial similarities to *Durvilledoris pusilla* (Bergh, 1874) in colour pattern, but in that species the central region is orange and the outer band is creamy yellow (Rudman, 1986b). Also the extensions of colour down each side extend from the central region out, which is the opposite to that of *Thorunna montrouzieri*.

Of the many new species of nudibranch collected or recognised by me during this study, so generously supported by the French Government, this one with the red, white and blue of the French flag would seem the most appropriate to name in recognition of this assistance. Unfortunately the most appropriate name, '*tricolor*', is already in use for a Mediterranean chromodorid. This species was collected while I was participating in the 'Montrouzier Expedition' to study marine biodiversity in northern New Caledonia. I have great pleasure in commemorating the French connection by naming this species '*montrouzieri*' after Father Xavier Montrouzier, a pioneering student of the fauna and flora of New Caledonia in the second half of the 19th century.

Table 2. Colour markings of *Noumea romeri* colour group.

	Mantle	Mantle border	Gill colour	Gills vibrate	Rhinophore
H. punicea	pink	white	yellow, red edge	Yes	Yellow, purple tip, red stalk
D. albofimbria	pink	white	orange edge	No	orange edge
H. bullocki	pink*	white*	orange edge, base purple	No	orange, purplish stalks
N. simplex	pink or white	whitish*	white, orange-red tip	No	orange tip
N. romeri	pink	white	orange-red edge	Yes	orange tip
T. speciosus	pink-purple	orange marg. cream submarg.	orange, red edge	Yes	orange with red edge & tip, purple stalk
N. verconiforma	white	whitish	red tip	Yes	red-orange tip
H. rosans	pink	white	yellow, red tip	?	yellow, red edges
C. albolimbata	reddish-white	white	?	?	?

* read discussion for colour variation

Discussion

Noumea romeri colour group.

In previous publications (Rudman, 1985, 1990, 1991) I have grouped similarly coloured species into colour-groups. These have no phylogenetic significance and simply reflect similarity in external colour. In this paper, a number of species are compared in which the mantle is pink, or purplish-pink, often with a thin white border. As described here, some of these species, such as *Hypselodoris punicea* and *Durvilledoris albofimbria*, can be found together, and although members of different genera, are almost impossible to distinguish externally (Table 2).

Two of these species, widespread in the tropical Pacific, *Noumea romeri* (Risbec, 1928) and *N. simplex* (Pease, 1871) were described and compared earlier (Rudman, 1984). *Noumea romeri* is pink with a narrow white border to the mantle. The vibratile gills are white, with orange-red edges, and the white rhinophores are tipped with orange-red. It can be distinguished from *N. simplex*, (which has both white and pink colour forms), in having an ill-defined whitish mantle edge, gills and rhinophores tipped with orange, and gills which do not wave rhythmically. To these two species, both recorded from New Caledonia, we can now add further similarly coloured species to confuse identifications. Two new species, *Hypselodoris punicea* and *Durvilledoris albofimbria*, both have a pink mantle and a narrow white border, as in *N. romeri*. One of these, *H. punicea*, matches *N. romeri* in also having vibratile red-lined gills. The main external difference is that *H. punicea* has a red rhinopore stalk, white in *N. romeri*. The second species, *Durvilledoris albofimbria*, differs from both in having the rhinophore club edged in orange, and in having non-vibratile gills. All these species are very similar in colour to the pink colour form of *Hypselodoris bullocki* (Collingwood, 1881), which has a thin white mantle border and pale orange gills and rhinophores. It can usually be distinguished by the raised gill pocket and the presence of purple or red pigmentation at the base of both the gills and rhinophore stalks.

Another species which also varies in background colour from white to pink, *Noumea simplex*, is superficially almost identical in colour to *N. verconiforma*, both having orange-tipped rhinophores and non-vibratile gills. The main external difference is that the mantle of *N. verconiforma* is textured with a reticulate pattern reminiscent of the texture of aplysillid sponges.

There are two other species, known only from the original descriptions, which probably fall into this colour group. As discussed earlier, *Hypselodoris rosans* (Bergh, 1889), from Mauritius is almost identical in colour to *H. punicea*, and the two appear to differ mainly in the denticulation of the radular teeth. *Chromodoris albolimbata* Bergh, 1907 was described from South Africa as reddish-white with a chalk-white mantle brim. It is not clear whether the colour description is of a preserved or living specimen. From the radular description, the species could either be a species of *Chromodoris* or *Glossodoris*.

Acknowledgements

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been possible without the valued assistance of the French Government who have provided funds for me to twice visit New Caledonia for 5 week periods, in 1988 and 1993, and to ORSTOM, Noumea (Institut Francais de la Mission de la Recherche Scientifique pour le Developpement en Cooperation) who on both occasions provided staff and logistical support. The 1993 visit, to northern New Caledonia, was as part of the Montrouzier Expedition studying tropical marine biodiversity. I am most grateful to Dr Philippe Bouchet, Museum National d'Histoire Naturelle, Paris, who organised this expedition, and staff from Paris and ORSTOM, Noumea for their valued assistance.

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Electronic Copy

An electronic copy (3.5" disc) of this paper, with colour photographs of all species, is available, at minimal cost, from the author. It requires MS Windows to run. Please direct enquiries to the author preferably with a return email or fax address.

Moll. Res. 16: 45–49 (1995).

Falcidens poias, a new species of chaetoderm Aplacophora from Rottnest Island, Western Australia (Chaetodermomorpha, Chaetodermatidae)

Amélie H. Scheltema
Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02543 USA

Contribution no. 8877 from Woods Hole Oceanographic Institution

Falcidens poias is a new aplacophoran species, the first to be described from Western Australia. It occurs amongst rhizomes of seagrass in Porpoise Bay, Rottnest Island, at densities of about 50 individuals m^{-2}. Its closest known relative is *F. lipuros* Scheltema from Bass Strait. The species is interesting both because of its unusually shallow occurrence at 3 m and its abundance.

Keywords: *Falcidens*, new species, Western Australia, Aplacophora

Introduction

Early records of Aplacophora off Australia were restricted to two (Thiele, 1897), but a number of species have recently been described (Scheltema, 1989, in press; Salvini-Plawen, 1992). This paper for the first time describes an aplacophoran species from Western Australia.

Class Chaetodermomorpha Pelseneer, 1906

Syn. Caudofoveata Boettger, 1956

Aplacophora lacking a ventral furrow and foot; with an oral shield and paired gills in the posterior mantle cavity; radula distichous.

Family Chaetodermatidae Marion, 1885

Radula with a single pair of denticles associated with a cone-shaped structure.

Genus *Falcidens* Salvini-Plawen, 1969

Syn. *Chaetoderma* Ivanov 1981 (non Lovén, 1844)

Paired denticles of radula sickle-shaped, attached to cone, and with accessory structures to guide radula movements.

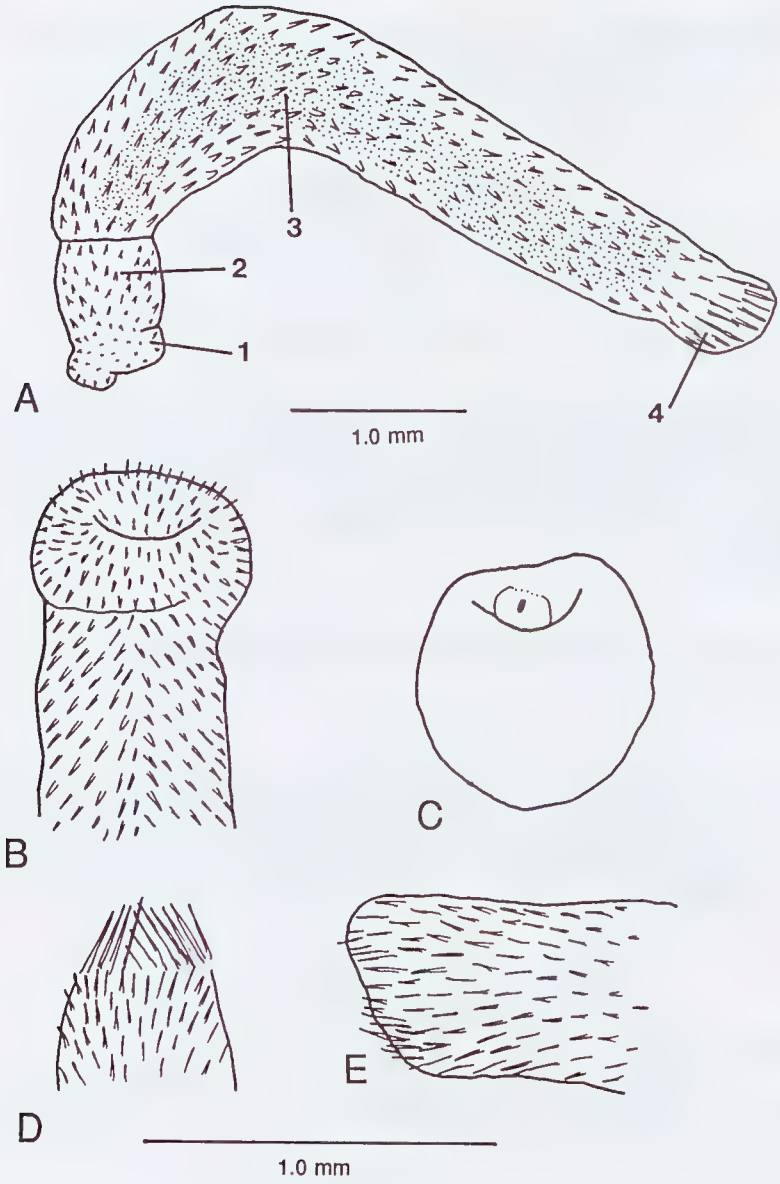

Figure 1. *Falcidens poias* n. sp. A, holotype, anterior to left; stomach and digestive gland shown in stippling. B, ventral anterior view of holotype showing diverging spicules. C, anterior end of anterium with oral shield, paratype; upper edge of shield and its relationship to mouth opening not clear. D, dorsal view of posterium, paratype. E, lateral view of posterium, holotype. 1, anterium; 2, neck; 3, trunk; 4, posterium.

Falcidens poias n. sp.

Type material: Holotype and paratype, Porpoise Bay, Rottnest Island, Western Australia, 3 m depth; collected 21 January 1991. Western Australia Museum nos. WAM 136–94 (holotype), WAM 137–94 (paratype).

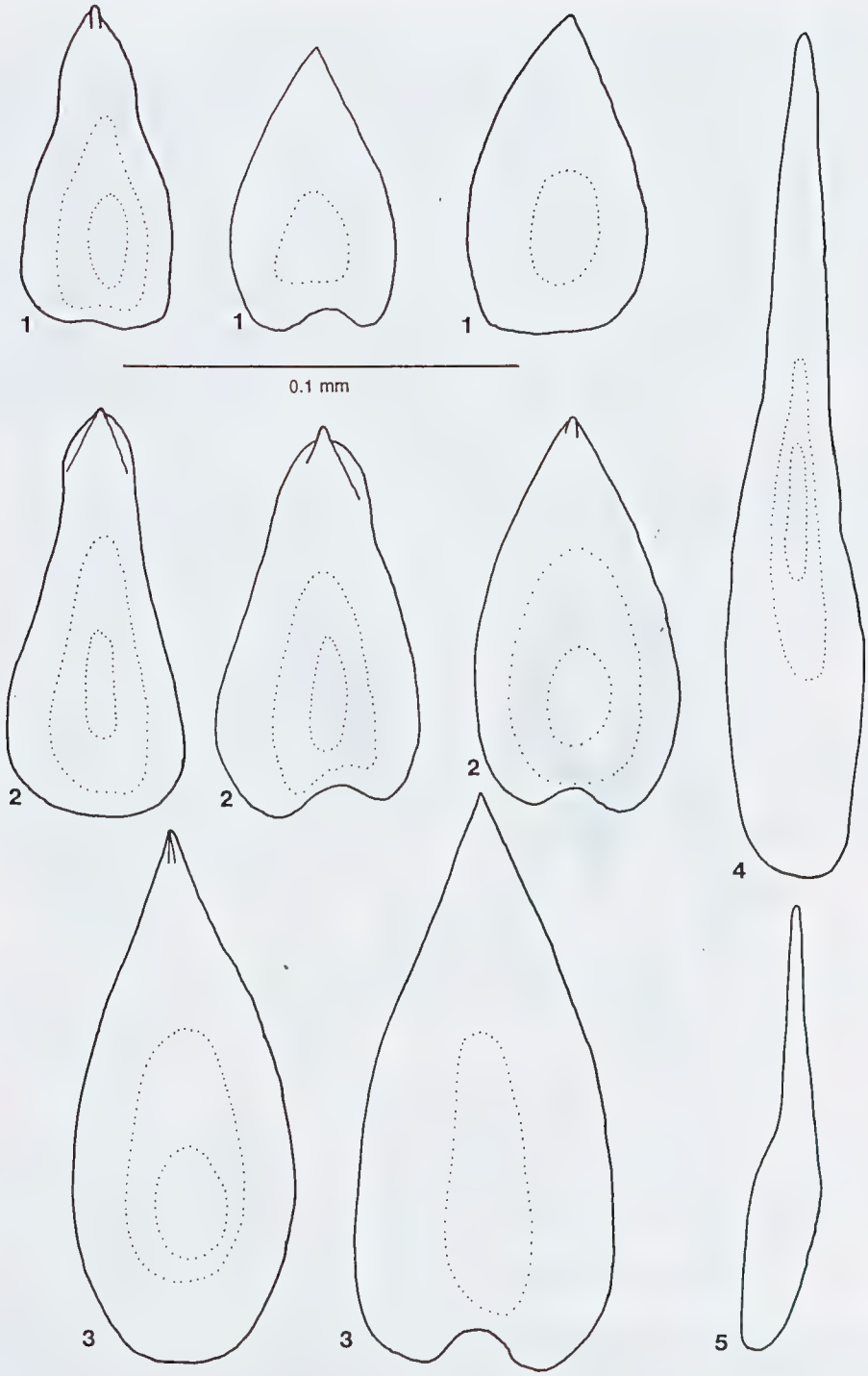

Figure 2. Spicules of *Falcidens poias* n. sp. 1, from mid-neck region; 2, from trunk adjacent to anterior constriction; 3, from trunk two-thirds of the way posterior to anterior constriction; 4, from encircling mantle cavity spicules; 5, from posterior mantle cavity wall beneath number 4 spicules. Dotted lines indicate isochromes, or lines of equal color and thickness when spicules are viewed with cross-polarized light.

Etymology: From *poias*, belonging to grass, from the habitat.

Description: A small species (Fig. 1), holotype 5.3 mm long by 0.8 mm in greatest width. Body translucent, anterium distinct, anterior constriction slight, and anterior trunk not differentiated from posterior trunk. Posterior end slanted in lateral view, tapered in dorsal view, dorsoterminal sense organ not evident. Anteriorly, trunk spicules diverge from ventral midline. Oral shield small, oval, wider (0.18 mm) than high (0.10 mm).

Spicules (Fig. 2) symmetrical except on posterior mantle cavity wall, flat, without sculpturing, rounded triangular or with a waist, with a distinct distal point, base rounded or notched. Spicules of anterium narrow rather than rounded triangular, and those of posterium with a long distal point. Greatest dimensions: neck spicules 74 μm long, 43 μm wide, and 6 μm thick; thickest spicules on trunk at anterior constriction, to 7 μm, length 115 μm, width 52 μm; trunk spicules from further posteriorly 146 μm long, 65 μm wide, and 6 μm thick; spicules longest from around mantle cavity, 214 μm, but narrow, 34 μm, and 6 μm thick.

Radula small (Fig. 3), total length 140 μm, with relatively large denticles about 60

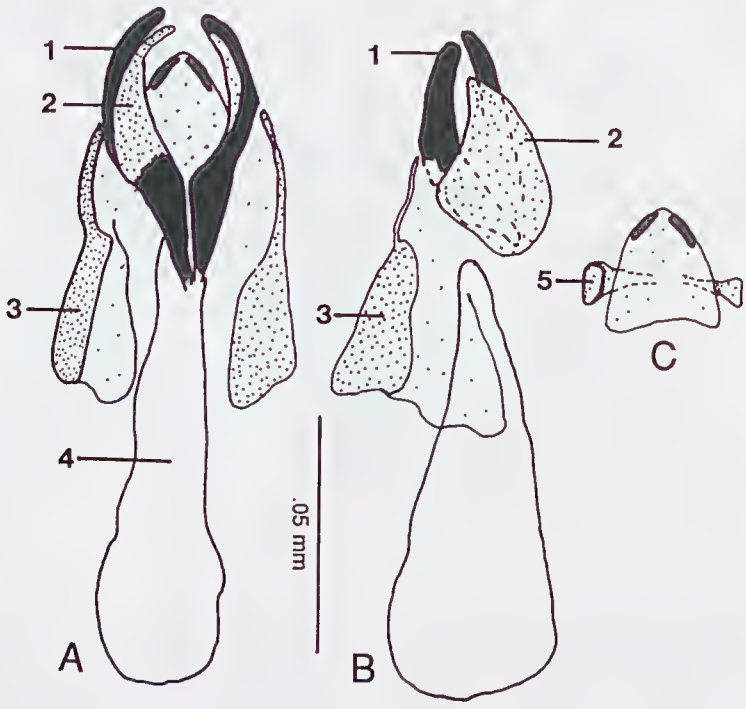

Figure 3. *Falcidens poias* n. sp. Radula of paratype. A, frontal view; B, lateral view; C, triangular back plate with tiny protuberances (black) and lateral apophyses (5) which wrap around the denticles (1). The relationships among the parts are not clearly depicted. The denticles of A and B (1, shown in black), are wrapped by a thin, second denticle-like pair (2, stippled) which are probably apophyses of the triangular plate (cf. Scheltema, 1972, fig. 1). The cone (4) is slightly wider in lateral than in frontal view and scarcely curved; the lateral membranes (3) lie outside the buccal mass, and are thickest where shown by stippling.

μm. Cone length 90 μm, frontal width 25 μm, lateral width 35 μm. Lateral membranes 55 μm long, positioned less than halfway down cone. Accessory structures were not clearly seen except for the triangular plate, which like the denticles is relatively large, and one pair of its apophyses.

Related species: *Falcidens poias* is most closely related to *F. lipuros* Scheltema from Bass Strait in general spicule and oral shield shape and in lack of distinctive anterior and posterior trunk regions (Scheltema, 1989). However, the spicules of *F. lipuros* are more elongate and often bear sculpturing at the waist, and the body is tapered posteriorly. The radulae of the two species are dissimilar.

Habitat: *Falcidens poias* was collected from amongst the rhizomes of the seagrass *Posidonia sinuosa* at densities of about 50 m^{-2}.

Discussion

Recent collections from Australia show that the aplacophoran fauna of the continental shelf is both diverse and abundant. In Bass Strait, species either have been or are in the process of being described (Scheltema, 1989, in press a, b; Salvini-Plawen, 1992). One species of Chaetodermatidae in Bass Strait, *Lepoderma chiastos* (Scheltema), occurs at high densities, up to 180 m^{-2} (Scheltema, 1989); *Falcidens (Lepoderma) targotegulatus* Salvini-Plawen (1992) is considered a synonym (Scheltema, in press b).

That a species of *Falcidens* has been found to occur at such shallow depths as 3 m and in warm surface waters is unusual, for this genus is normally found in cold temperate waters and often at upper slope depths. The accessibility of *F. poias* in relatively large numbers at easy collecting depths opens the possibility for behavioral and physiological studies of an aplacophoran, a group for which few such data are available.

Acknowledgements

Two specimens of this new species were sent to me by Graham Edgar, for which I thank him.

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Two additional species of *Dermomurex* (Gastropoda: Muricidae) from southern Australia

Emily H. Vokes

Department of Geology
Tulane University
New Orleans, Louisiana 70118 USA

Two new species of the muricid genus *Dermomurex* are described from southern Australia. The first of these, *Dermomurex* (*Dermomurex*) *agnesae*, from King George Sound, Western Australia, is the fifth known Australian member of this subgenus, which is found primarily in the New World, but also occurs in the Mediterranean. The second, *Dermomurex* (*Viator*) *howletti*, from St. Francis Isles, Nuyts Archipelago, South Australia, and Esperance, Western Australia, is the fifth taxon to be described in this exclusively Australian subgenus and the first living species from the southern part of the continent.

Keywords: *Dermomurex*, new species, Western Australia, South Australia.

Introduction

In the past quarter century there has been a virtual explosion of species of *Dermomurex*, a previously little known group of muricine gastropods first described from the Mediterranean. Prior to 1985 there were but three Australian species included in *Dermomurex* (Vokes, 1974); however, in a review of Australian members of the genus (Vokes, 1985), a total of ten species (three living and seven fossil) were recognised. Since then another two species have been described for a total of five Recent taxa, three of which are assigned to *Dermomurex* s.s.: *D. goldsteini* (Tenison-Woods, 1876), *D. angustus* (Verco, 1895), and *D. raywalkeri* Houart, 1986; and two to the subgenus *Viator*: *D.*(*V.*) *antonius* Vokes, 1974, and *D.*(*V.*) *pasi* Vokes, 1993.

In terms of modern distribution the genus *Dermomurex* is primarily New World, with a total of 15 western Atlantic and five eastern Pacific species. The eastern Atlantic has but two (one Mediterranean and one west African) and the Indo-Pacific, exclusive of Australia, has another four species. With the addition of these two new taxa, there is now a total of seven living forms of *Dermomurex* in the waters surrounding Australia, making this area second only to the western Atlantic in number of species.

Abbreviations: AMS, The Australian Museum, Sydney; MV, Museum of Victoria, Melbourne; SAM, South Australian Museum, Adelaide; WAM, Western Australian Museum, Perth.

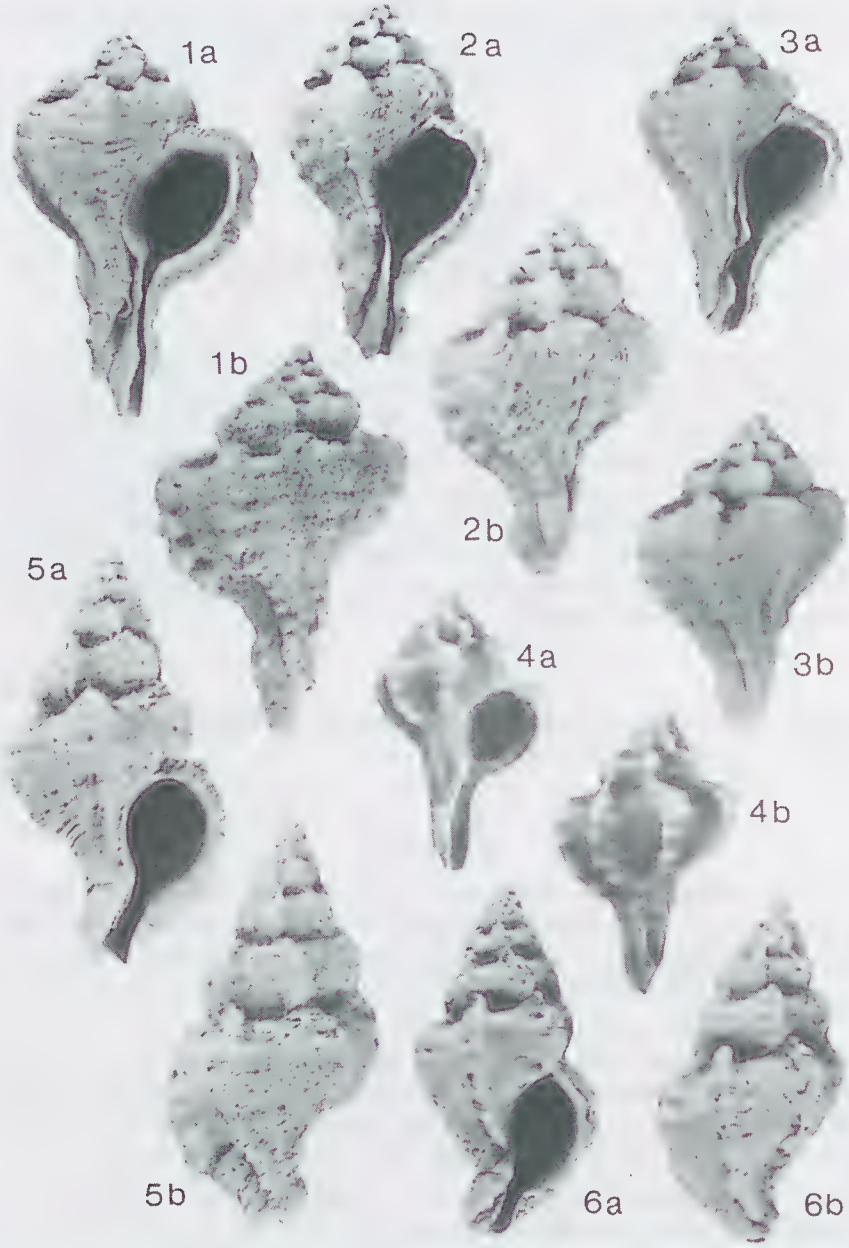


Plate 1. Figures 1–4. *Dermomurex* (*Viator*) *howletti* Vokes, n.sp. 1. MV F.74871 (holotype); length 25.8 mm, diameter 17.6 mm. 2. AMS C.300905 (paratype A); length 24.2 mm, width 15.5 mm. 3. AMS C.96359 (paratype B); length 21.0 mm, width 14.3 mm. Locality: All from off St. Francis Isles, Nuyts Archipelago, South Australia, dredged in 25–30 m. (All X 2). 4. WAM 211-94 (paratype C); length 18.4 mm, width 11.9 mm. Locality: Off Esperance, Western Australia, in 37 m. (X 2). 5, 6. *Dermomurex* (*Dermomurex*) *agnesae* Vokes, n.sp. 5. WAM 209-94 (holotype); length 13.9 mm, width 7.0 mm. 6. WAM 210-94 (paratype), length 12.0 mm, width 6.4 mm. Locality: Both from off Mistaken Island, King George Sound, Albany, Western Australia, in 12 m. (Both X 4).

Systematic Descriptions

Family Muricidae Rafinesque, 1815

Subfamily Muricinae Rafinesque, 1815

Genus *Dermomurex* Monterosato, 1890

Dermomurex Monterosato, 1890, p. 181. New name for *Poweria* Monterosato, 1884, *non* Bonaparte, 1840.

Type species: *Murex scalarinus* Bivona-Bernardi, 1832, = *Murex scalaroides* Blainville, 1829 (*O.D.*).

Subgenus *Dermomurex* s.s.

Dermomurex (*Dermomurex*) *agnesae* Vokes, n.sp.

Plate 1, figures 5, 6

Description: Shell small (maximum length under 15 mm), biconic, with five teleoconch whorls and protoconch of 1.5 smooth, bulbous whorls, ending at a sharp varix. Without intritacalx present, shell lacking spiral ornamentation; axial ornamentation on first post-nuclear whorl of six low rounded ridges, decreasing to five on all subsequent whorls; varices projecting slightly at mid-point of whorl. With intritacalx present, varices with raised crests, undulated by faint spiral ridges; free-standing flanges on siphonal canal. Entire external shell covered by thick, dirty-white intritacalx, smooth when fresh, with only faint axial growth lines and deep pits along adapertural edge of varices; when worn, marked by punctate spiral tubes. Aperture rounded, inner lip smooth, appressed along entire length. Inner side of outer lip smooth. Siphonal canal short, broad, recurved dorsally. Shell beneath intritacalx, and within aperture, pale peach. Operculum typically muricine with apical nucleus.

Type material: Holotype: WAM 209-94; length 13.9 mm, width 7.0 mm (pl. 1, fig. 5). Paratype: WAM 210-94, length 12.0 mm, width 6.4 mm (pl. 1, fig. 6). Both collected by Johan Pas, 1994. Three additional unfigured paratypes: one (10.3 mm X 6.0 mm) in the collections of the Australian Museum (AMS C.305214); the remaining two in the collection of Mr Pas.

Type locality: Off Mistaken Island, King George Sound, Albany, Western Australia (30°04'S, 117°55'E), in 12 m, among coralline algae rubble; four dead shells, only the figured paratype taken live.

Etymology: Because I had previously named a species of *Dermomurex* in honour of Mr. Pas, we agreed upon the name of his wife, Agnes Pas, for this second new species he has discovered.

Discussion: As has been noted previously (Vokes, 1985: 48), the Australian species referred to *Dermomurex* s.s. differ from the type species of the genus, *D. scalaroides* (Blainville) in that in the typical form, on the adult body whorl, the varices are reduced from six per whorl to only three. In the previously described living Australian species assigned to the strict subgenus, this reduction does not occur and the shells retain six

varices throughout their growth. Nevertheless, the similarity to *D. scalaroides* is sufficiently close that I see no reason to separate them.

The new species also does not reduce the number of varices on the last whorl and, in this respect, is like the other three living Australian species, but beyond that has no great resemblance. *Dermomurex agnesae* is much smaller than *D. goldsteini*, a wider shell (length/width ratio almost exactly 2 in *D. goldsteini*, compared with a ratio of less than 2 in *D. agnesae*). *Dermomurex angustus* is of similar size (both about 10 to 12 mm) but has a very elongate outline, with a length/width ratio greater than 2. The varices in *D. goldsteini* are heavy raised ribs that extend from the suture to the tip of the siphonal canal; those in *D. angustus* are somewhat weaker but also are developed as raised ridges along the entire length of the body whorl. In *D. agnesae* the varices are much reduced and nearly disappear entirely at the periphery.

In length/width ratio this new species is nearest to the Western Australian species *D. raywalkeri* Houart. However, the latter has the strong varices of *D. goldsteini* and a distinctive intritacalx with marked spiral grooves. The shell outline in *D. agnesae* is almost biconic with the body whorl tapering sharply from a maximum width at the midpoint of the length into the short siphonal canal. The outline in *D. raywalkeri* is more nearly cylindrical, with the siphonal canal very short and recurved distally.

The greatest difference between *D. agnesae* and the three other Recent Australian species is the development in the new species of only five varices on all but the first teleoconch whorl. This gives it some similarity to the adult shell of the fossil species referred to *Dermomurex* s.s., the Miocene *D. garrardi* Vokes, 1985, which is an extremely elongate shell (length/width ratio of 2.5) that decreases the varices on the body whorl to only three and may well be better referred to the subgenus *Trialatella* (see discussion in Vokes, 1985: 49).

At this time, the only record of *D. agnesae* is from the type locality, King George Sound, but further collecting will probably extend the range to the east. *Dermomurex angustus* until recently was known only from the Gulf of St. Vincent, South Australia, but Houart (1986: 171, fig. 3) has extended the range to Hopetoun (ca. 200 km west of Esperance), Western Australia, and it is probable that the range of *D. agnesae* will prove to be similar.

Subgenus *Viator* Vokes, 1974

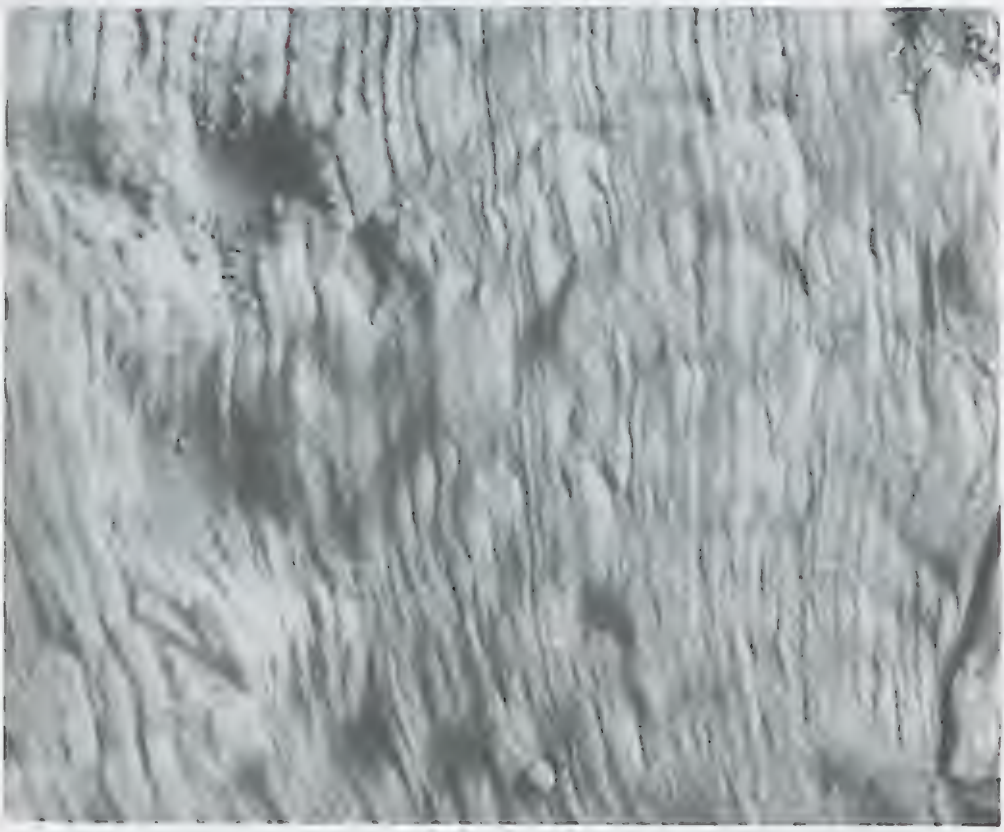
Viator Vokes, 1974: 4.

Type species: *Dermomurex* (*Viator*) *antonius* Vokes, 1974 (*O.D.*).

Dermomurex (*Viator*) *howletti* Vokes, n. sp.

Plate 1, figures 1–4; text-figure 1

Description: Shell large for subgenus (maximum length over 25 mm), about 1.5 bulbous protoconch whorls and five teleoconch whorls, no exact line of demarcation between the two. With intritacalx absent, spiral ornamentation of faint threads and five vague larger cords on body whorl, more obvious where crossing varices. Axial ornamentation on each teleoconch whorl of six heavy raised ridges, with slight projections at shoulder. With intritacalx present, varices expanded, with strong

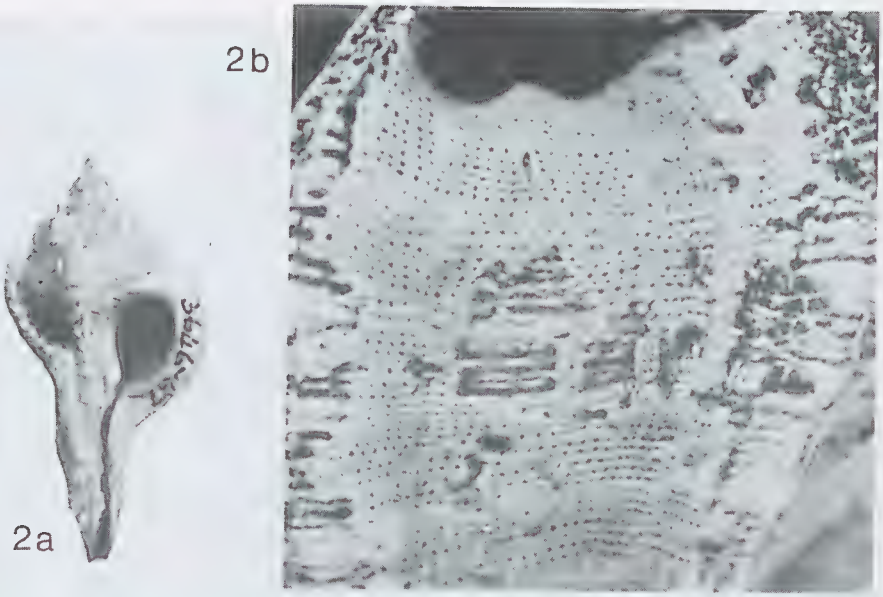


Text-figure 1. *Dermomurex* (*Viator*) *howletti* Vokes, n. sp. AMS C.300905 (paratype A); detail of intritacalx, X 20.

abaperturally recurved fold at shoulder; undulated by augmented spiral cords; somewhat flaring on extended siphonal canal. Entire external surface covered by thick, dirty-white intritacalx, corrugated by axial growth lines, crossed by faint spiral grooves with minute punctae (best seen when worn) and larger indistinct pits, randomly arranged. Aperture asymmetrically oval, inner lip smooth, appressed along entire length. Inner side of outer lip also smooth. Siphonal canal long, almost straight except for slight fold about midway along its length, exaggerated by presence of intritacalx. Shell beneath intritacalx golden-brown, white where spiral cords cross varices. Operculum typically muricine, with apical nucleus.

Type material: Holotype: MV F.74871; length 25.8 mm, diameter 17.6 mm (pl. 1, fig. 1). Paratype A: AMS C.300905; length 24.2 mm, width 15.5 mm (pl. 1, fig. 2; text-figure 1). Paratype B: AMS C.96359; length 21.0 mm, width 14.3 mm (pl. 1, fig. 3). All collected by D. Howlett. Paratype C: WAM 211-94; length 18.4 mm, width 11.9 mm (pl. 1, fig. 4), collected by A. Edinger.

Additional unfigured paratypes: WAM 212-94, length 19.2 mm, width 12.6 mm, collected by A. Edinger; SAM D.18943, length 20.7, width 13.0, collected by D. Howlett.



Text-figure 2. *Dermomurex* (*Viator*) *antonius* Vokes. WAM 3634–67 (holotype); length 25.7 mm, width 13.4 mm; locality, Dampier Archipelago, Western Australia. (2a, shell, X 2; 2b, detail of intritacalx, X 20).

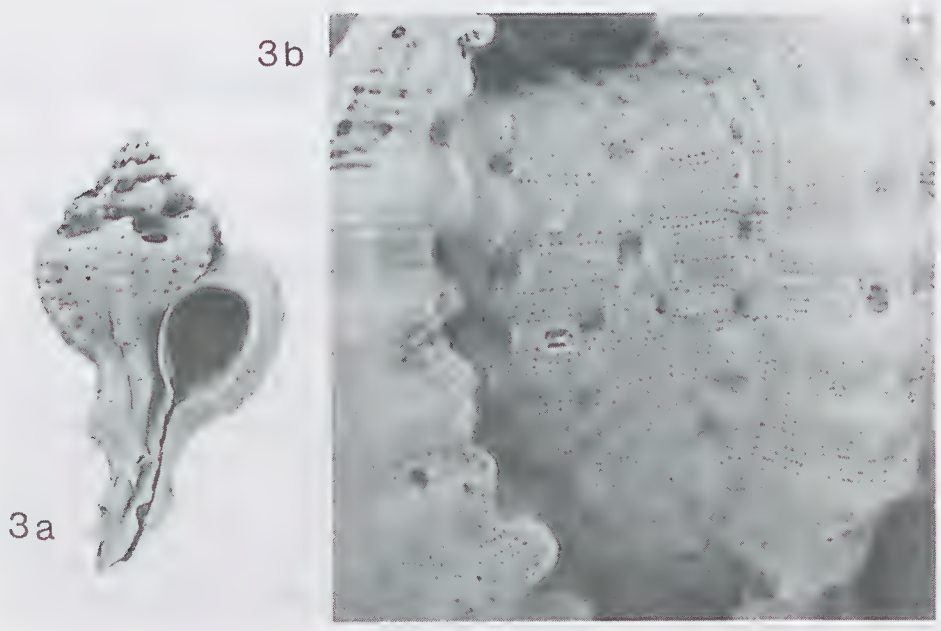
Type locality: 1 km west of Smooth Island, north side St. Francis Isles, Nuyts Archipelago, South Australia (32°31'S, 133°18'E), dredged in 20–30 m, December, 1973; additional material: same locality, 1974–75. Paratype C taken off Esperance, Western Australia, in 37 m, by A. Edinger, 1994.

Etymology: Named in honour of David Howlett, Port Lincoln, S.A., who collected most of the type lot.

Discussion: After the description of *Dermomurex* (*Viator*) *pasi*, the second species of *Viator* from northwestern Australia (Vokes, 1993), David Howlett, Port Lincoln, South Australia, informed me of specimens resembling *D.*(*V.*) *antonius* from off the coast of South Australia. Examination of this material showed it to distinct from both *D. antonius* and *D. pasi*, but remarkably close to the Miocene species, *D.*(*V.*) *asteriscus* (Tate, 1888), described from the Balcombian Muddy Creek Marl at Hamilton, Victoria.

In general appearance this new species is mid-way between *D.*(*V.*) *antonius* (text-fig. 2a), with a completely straight siphonal canal, and *D.*(*V.*) *pasi* (text-fig. 3a), which has a twist to the siphonal canal. The siphonal canal in *D.*(*V.*) *howletti* has a slight twist, but not as strong as that in *D.*(*V.*) *pasi.*

The three living species all have a thick intritacalx, but each is distinctive: *D. antonius* (text-fig. 2b) has spiral rows of punctae; *D. pasi* (text-fig. 3b) also has spiral rows of punctae, but they are relatively smaller, and the entire surface is marked by square pits, giving the intervarical area a checker-board appearance. The intritacalx of *D. howletti* is only minutely punctate and consists of axially elongate rugae (text-fig. 1), which give the shell a completely different surface texture. Unfortunately, no specimens of *D. asteriscus* have the intritacalx preserved.



Text-figure 3. *Dermomurex* (*Viator*) *pasi* Vokes. WAM 237–93 (holotype); length 18.0 mm, width 10.9 mm; locality, Broome, Western Australia. (3a, shell, X 3; 3b, detail of intritacalx, X 20).

The overall shell shape of *D. howletti* is much like that of *D. asteriscus*, having a lower spire than the two northern forms, although the fossil species has the straight siphonal canal of *D. antonius*. The second fossil species, *D.*(*V.*) *darraghi* Vokes, 1985, described from the slightly older (Batesfordian) Gillebrand Clay of Victoria, also has an absolutely straight siphonal canal, but the body whorl is less inflated than *D. howletti*, tapering rapidly from the shoulder into the siphonal canal. The smallest paratype (Paratype C) has lost all of its intritacalx, revealing the underlying sculpture of the shell and it can be seen that the new species differs from *D. asteriscus* in being completely smooth between the varices, in contrast to the strong spiral cords seen in the latter (compare Vokes, 1985: pl. 3, figs. 1,2). It also shows the shell to be a dark golden-brown with white varices.

Acknowledgements

Once again, I am indebted to Johan Pas, Albany, Western Australia, who sent to me the type lot of *D. agnesae*. The original lot of four specimens of *D. howletti* was collected by David Howlett, Port Lincoln, South Australia. Subsequently Andrew Edinger, Mandurah, Western Australia, sent for identification two specimens of the same species, but collected at Esperance, Western Australia. He generously contributed his specimens to the collections of the Western Australia Museum, and I am grateful to him for this extension of range for the species. The collections managers of both the Museum of Victoria (Suzanne Boyd, Chris Rowley) and the Australian Museum (Ian Loch) kindly loaned material for this study.

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A new species of *Pythia* Röding, 1798 (Pulmonata, Ellobiidae), from New Ireland, Papua New Guinea.

António M. de Frias Martins
Departamento de Biologia
Universidade dos Açores,
P-9502 Ponta Delgada São Miguel, Açores
Portugal

Pythia colmani, a new species from the rainforest of New Ireland, Papua New Guinea, is described. The anatomy of the reproductive and nervous systems is studied in detail. The reproductive system agrees with the patterns observed for other species of the genus. The central nervous system, however, presents a slight divergence from patterns previously recognized in the Pythiinae; the right parieto-visceral connective, in the new species, is less than half the length of its left counterpart, whereas in other pythiine species it is slightly longer than half the length of the left parieto-visceral connective. Taking into consideration that the length of the right parieto-visceral connective is nevertheless appreciable, the significance of this deviation from previously recognized diagnostic characters of subfamilial division of the Ellobiidae is minimized. The new species is compared to *Pythia scarabaeus* (Linnaeus, 1758), *P. pyramidata* (Reeve, 1842), *P. argenvillei* Pfeiffer, 1853 and *P. savaiensis* Mousson, 1869, from which it differs mainly by its more slender, longer shell, by the position of the first outer lip tooth and by the shape of the pseudo-umbilicus.

Key words: Ellobiidae, Pythiinae, *Pythia*, morphology, anatomy.

Introduction

Pythia Röding, 1798 is an Indo-Pacific ellobiid genus, common in mangroves from above high tide to completely terrestrial environments. It is readily distinguishable from all other ellobiid genera due to the dorso-ventrally flattened shell with characteristically heavily dentate aperture. However, most described species of *Pythia* are morphologically similar, thus rendering difficult specific separation of some taxa on shell features alone. A review of the genus, based on anatomical characters, is therefore needed to ascertain the taxonomic status of most names.

Anatomical studies of the genus are scanty. Plate (1897) gave the first anatomical account of *Pythia scarabaeus* (Linnaeus, 1758) and Berry *et al.* (1967) provided a detailed description of the reproductive system of the same species. Martins (in press a) discussed the central nervous system of *P. plicata* (Férussac, 1821) and Martins (in press b) figured the internal morphology of the penial complexes of *P. cecillei* (Philippi, 1847) and of *P. fimbriosa* Möllendorff, 1885, alluding to the importance of the latter feature as a diagnostic specific character.

In this work a new species of *Pythia* from New Ireland, Papua New Guinea, is described, and the anatomy of the reproductive and nervous systems is studied.

Materials and Methods

The present study was based on specimens collected on July 18, 1990 at Medina, ca. 110 km South of Kavieng on E coast of New Ireland, Papua New Guinea. Five specimens were preserved in 70% ethanol and 40 specimens are represented by dead shells. Two specimens were dissected under a Wild binocular microscope and drawn using camera lucida. The radula of one specimen was stretched across a cover slip after cleaning with KOH solution. The penial complex was dissected and submitted to critical point drying. Both structures were mounted on stubs, and examined and photographed using a Cambridge Stereoscan 250 Mk2 SEM.

Systematics

Class Gastropoda Cuvier, 1797

Subclass Pulmonata Cuvier, 1817

Order Archaeopulmonata Morton, 1955

Family Ellobiidae H. & A. Adams *in* Pfeiffer, 1854

Subfamily Pythiinae H. & A. Adams *in* Pfeiffer, 1854

Genus *Pythia* Röding, 1798

Pythia colmani, new species.

Description. Shell (Figs. 1A, B; 2A, B, C, D): length to 34 mm, conico-elongated, narrowly pseudo-umbilicated, dorso-ventrally flattened, somewhat thin, finely striated longitudinally, striae marked near suture. Spire decollate in adult shells, moderately high, 9–10 whorls, bearing on each side a carina with whitish varices highlighted by preceding longitudinal dark-brown spots (Fig. 2B); the carinae result from partial retention of the labial callus, at the posterior third of the outer lip, in successive growth periods; first 5 whorls dark-purple, a brownish-green band then developing on the shoulder, increasing and becoming lighter on the following whorls, displacing on the last two whorls the purple color of the early whorls. Body whorl about 65% of shell length, major diameter to 16 mm and minor diameter to 12 mm, greenish-yellow to white with irregularly dispersed brown spots; in lighter, sparsely dotted specimens three equidistant, fine brown lines are visible, the first halfway between the suture and the posterior angle of the aperture, the second arising from the posterior border of the aperture, and the third band arising from the anterior tip of the posterior parietal tooth (Fig. 2C, D); this coloration pattern is usually masked in darker, more heavily dotted specimens. Aperture subvertical, oval, narrow, rounded anteriorly, acute posteriorly; peristome weakly thickened, reflected somewhat and expanded over columella, forming a narrow, roundish pseudo-umbilicus, anterior and posterior margins connecting through a shining callus; inner lip the same color as body whorl, with three subequidistant light-brownish teeth: one strong, oblique columellar tooth, flaring up posteriorly, continuous with columellar lip anteriorly and forming a narrow, roundish

Figure 1. Holotype of *Pythia colmani* Martins, new species (Australian Museum, Sydney C.304290), sl: 31.0 mm. A, apertural view; B, side view.

canal; two parietal teeth, the anterior one strongest, entering aperture horizontally to columellar plane, plate-like, flaring up, sometimes with a small denticle hidden anteriorly at base; posterior parietal tooth vertical to columellar plane, elongated, bifid, sometimes discontinuous, the anterior portion strongest, triangular, tapering posteriorly; outer lip posteriorly retracted to form an angular, white varix, anteriorly expanded, lighter than inner lip and spotted, with 5 subequidistant denticles, the anterior-most (first) lamelliform, entering aperture opposite columellar tooth, the second weakest, the third strongest, oblique, forth and fifth subequal, tuberculiform, the fifth slightly smaller, opposite posterior tubercle of second parietal tooth. Wall of the inner whorls resorbed except for the last two whorls; in the other, upper whorls a small portion of the wall remains attached to the shell.

Radula (Fig. 3A, B): formula [27+19+1+19+27] x 110. Central tooth below the plane of the lateral teeth; base subrhomboid, deeply emarginate; crown very small, oval-elongate, unicuspid, mesocone rounded at tip. Lateral teeth 19, base elongated, slightly oblique, with lateral projections flaring out somewhat symmetrically at about half the length of the base, the inner one smaller, the outer one widely rounded; crown large, covering half of the base, ovoid, with a small median elevation posteriorly, roughly bicuspid anteriorly; a rudimentary endocone and a wide, triangular mesocone with blunt cusp. Transition to marginal teeth indicated by a change of direction of the rows posteriorly relative to the plane of the central and lateral teeth. Marginal teeth 27,

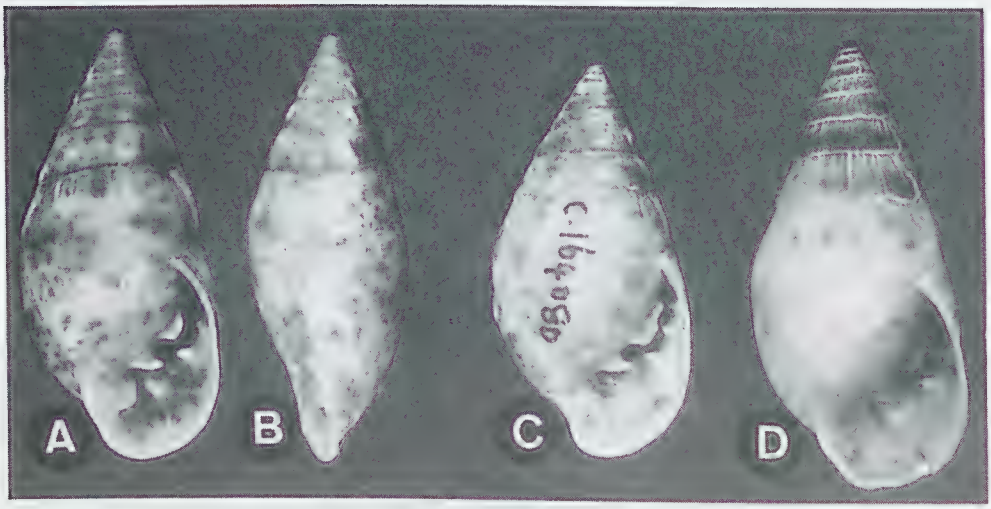

Figure 2. Shells of *Pythia colmani* Martins, new species. A, Apertural view and B, lateral view of the holotype (Australian Museum, Sydney C.304290), sl: 31.0 mm; C, Paratype 1 (Australian Museum, Sydney C.164080), sl: 28.1 mm; D, Paratype 2 (Australian Museum, Sydney C.164080), sl. 32.2 mm.

gradually decreasing in size, with short bases and oval-elongated, rounded crowns; subterminally to the crown cusp, the last 13 marginal teeth develop a small, blunt endocone which becomes as strong as the mesocone in the last 3–4 marginal teeth.

Visceral mass: conical, following external winding of shell, with whorl impressions deeply marked by the remnants of the inner shell walls. Pallial cavity very deep; kidney long, narrow and yellowish, opening by a terminal kidney pore near the posterior bend of the pallial gland; a thick, weakly spiralled pallial organ, located on the left side of the pallial cavity, opens into the mantle skirt groove; when the animal retracts into its shell, the anterior end of the pallial organ occupies the canal formed by the forward expansion of the columellar tooth.

Stomach (Fig. 4): tripartite; cardiac region dilated, thin; mid-portion comprising an anterior muscularized band and a posterior thinner bottom, with a subterminal, dilated

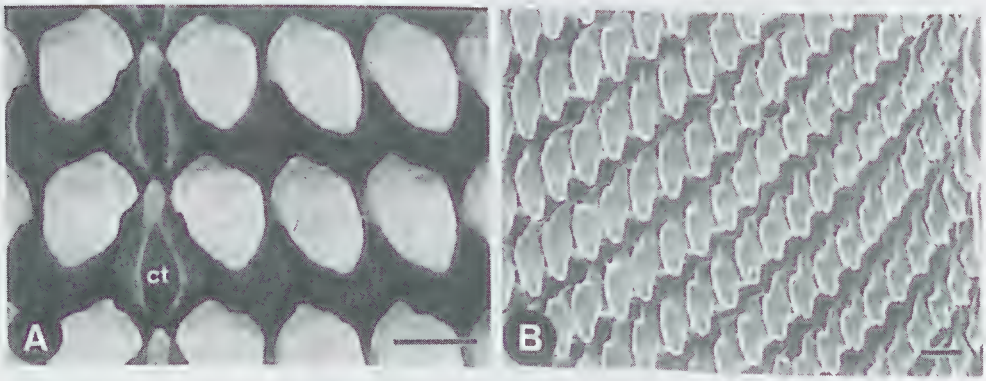

Figure 3. Radular teeth of *Pythia colmani* Martins, new species. A, central and lateral teeth; B, marginal teeth. Scale bars: 30 μm.

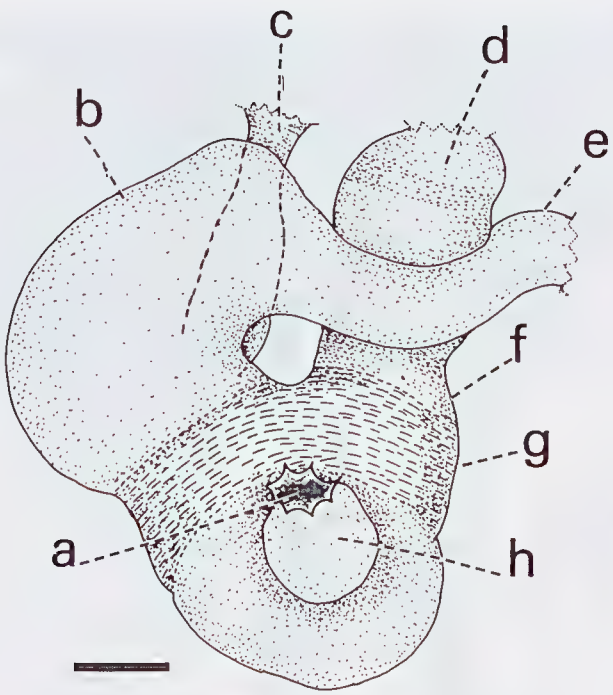

Figure 4. Stomach of *Pythia colmani* Martins, new species. Scale bar: 1 mm.

and thin gastric caecum receiving posterior diverticulum; pyloric region cylindrical, thin.

Reproductive system (Figs. 5A–E, 6A, B): ovotestis embedded in the winding posterior lobe of the digestive gland; proximal portion of the hermaphroditic duct thin, relatively straight, distal portion forming a convoluted, somewhat dilated seminal vesicle; pallial gonoduct hermaphroditic to the vaginal aperture; albumen gland underneath the anterior lobe of digestive gland and intestinal convolutions; two convoluted posterior mucous glands, the distal one more tightly coiled, overlapping proximal end of anterior mucous gland; the latter and the prostate gland cover the entire length of spermoviduct; bursa spherical, fitting underneath proximal posterior mucous gland and albumen gland; duct of bursa as long as spermoviduct, emptying near vaginal opening, opposite pallial gland opening. Pallial gland sharply bent about midway, the two halves about the same thickness, the anterior one tapering to its opening near the female aperture. Penial complex (Fig. 5C) small, club-shaped, with proximal end dilated; penial retractor splitting near penial attachment, inserting subapically at each side of the anterior vas deferens, where the latter enters the penis (Fig. 5D); anterior vas deferens tightly adhering to penial sheath; penis occupying proximal quarter of penial complex, cylindric, finely striated transversely; penial sheath dilated and thin, forming a pouch around the penis, narrowing distally; internal wall of penial pouch finely grooved transversely, distal portion with fine, longitudinal, irregular grooves; a raised longitudinal area marks the site where the anterior vas deferens adheres to the outside wall of the penial sheath, but no true pilasters were observed (Figs. 5E, 6A, B).

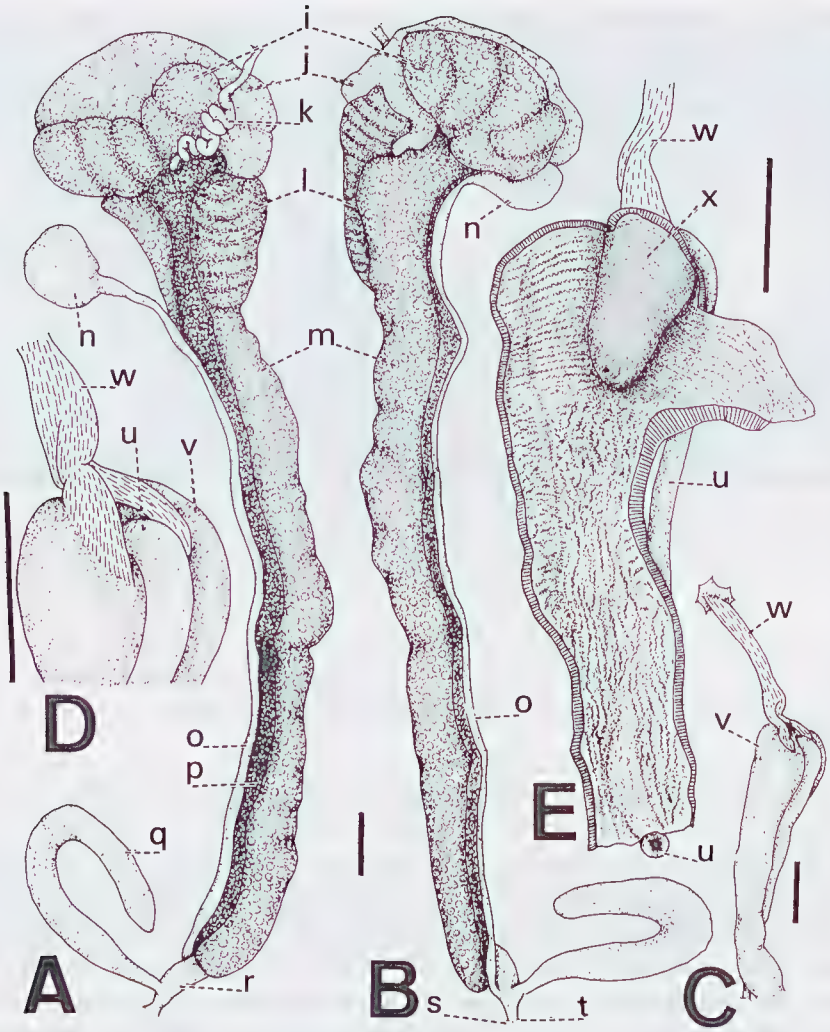

Figure 5. Reproductive system of *Pythia colmani* Martins, new species. A, ventral and B, dorsal views of the hermaphroditic portion, except the gonad; C, penial complex; D, detail of the proximal portion of the penial complex; E, internal morphology of the penial complex. Scale bars: 1 mm.

Nervous system (Fig. 7): cerebral commissure somewhat longer than the width of a cerebral ganglion; cerebro-pleural connectives about half as long as cerebro-pedal connectives; visceral nerve ring very wide, with clear remnants of chiastoneury; left pleuro-parietal connective very short, half the length of the right one; left parieto-visceral connective very long, passing underneath right parieto-visceral connective to connect with right side of visceral ganglion.

Type locality. Medina, ca. 110 km S of Kavieng on E coast of New Ireland, Papua New Guinea, ca. 2°56'S, 151°22'30"E. Location of type series. Holotype: Australian Museum, Sydney, C.304290; paratypes (32 dry shells and 4 wet), Australian Museum,

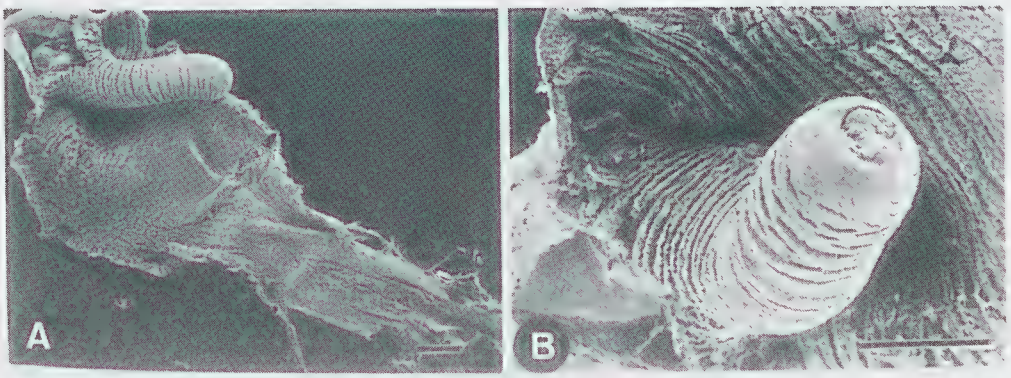

Figure. 6. Internal morphology of the penial complex of *Pythia colmani* Martins, new species. A, overall view; B, penis. Scale bars: 300 µm.

Sydney, C.164080; one additional dry paratype was deposited in each of NHM, London, MNHN, Paris, USNM, Washington, LACM, Los Angeles, ZM, Amsterdam; NMNZ, Welligton, and Natal Museum, Pietermaritzburg.

Etymology. This species is named after P.H. Colman, Technical Officer, Australian Museum, Sydney, who collected and kindly provided the specimens and patiently awaited the completion of this study.

Habitat notes. *Pythia colmani* was collected in limestone doline, at about 100 m altitude, in rainforest.

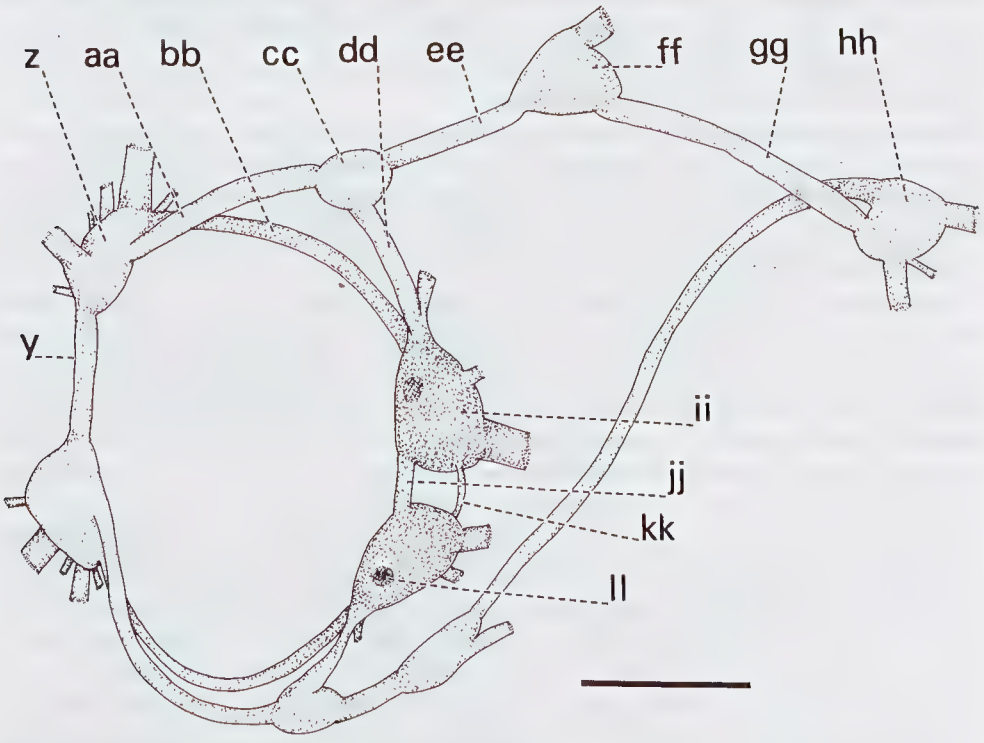

Figure 7. Central nervous system of *Pythia colmani* Martins, new species. Scale bar: 1 mm.

Remarks. *Pythia colmani* belongs to the large and variable group of mottled *Pythia* species which includes the widespread *P. scarabaeus*. The comparisons that follow are not intended to unravel the taxonomic position of the few species in question. Such a quest would definitely require a study of the anatomy, since conchological characters alone sometimes seem inconclusive, as shown by the morphological variability seen throughout the distributional range of the genus. *Pythia colmani* is more slender than *P. scarabaeus*. In the latter species the pseudo-umbilicus is wide and shows clearly the anterior portion of the previous last whorl, whereas in the new species the pseudo-umbilicus is narrow and completely hides the anterior tip of the previous last whorl. Also, the anteriormost outer lip tooth in *P. scarabaeus* is located nearer the plane of the anterior parietal tooth, whereas in the new species the first outer lip tooth is located opposite the columellar tooth. *Pythia pyramidata* was described by Reeve (1842: 221; fig. 12) as "the most oblong of the different forms"; however, the yellowish color of the mouth, the pseudo-umbilicus of the "*scarabaeus*"-type and the wider base that gives it the pyramidal outline, set this species apart from the new species described here. The slender, Australian *Pythia argenvillei* Pfeiffer, 1853 is comparable to *P. colmani*, but is smaller; Pfeiffer (1853) recorded a length of 26 mm and maximum diameter of 13 mm for his species. The position of the anterior outer lip tooth approaches that observed in the new species. However, the pseudo-umbilicus of *P. argenvillei* is similar to that observed in *P. scarabaeus,* apparently justifying Smith's (1992) decision to consider Pfeiffer's species a junior synonym of *P. scarabaeus*. Mousson (1869) described *Pythia savaiensis* from Savai'i and Manua, Samoa Islands, which also can be compared with the new species. Mousson's species, although somewhat more elongated than most *P. scarabaeus*, is stouter than *P. colmani* and has only four teeth in the outer lip, of which the first one lies opposite the anterior parietal tooth. The pseudo-umbilicus of *P. savaiensis* resembles that of *P. scarabaeus*, thus pointing at a close relationship between these two species.

The reproductive system of *Pythia colmani* conforms to the patterns previously observed for other species in the genus (Plate, 1897; Morton, 1955; Berry *et al.,* 1967). The penis shows fine transverse striation, similar to that recorded by Martins (in press b) for *P. cecillei* and *P. fimbriosa*, from Hong Kong; such striated pattern seems to be a typical feature of the genus.

The central nervous system of the new species differs somewhat from that of other *Pythia* species studied by Martins (in press a, b) in that the right parieto-visceral connective, although long, is much shorter than its left counterpart, a situation somewhat similar to that observed in the ellobiine *Auriculastra subula* (Quoy & Gaimard, 1832) (Martins in press b, c). Martins (in press a, b) recognized three types of central nervous systems in the Ellobiidae: 1) Pythiinian, with large visceral ring and with long right parieto-visceral connective; 2) Ellobiinian-Carychiinian, with wide visceral nerve ring and short right parieto-visceral connective; 3) Pedipedinian-Melampinian, with short visceral nerve ring. The situation in *Pythia colmani*, although not invalidating the subfamilial patterns referred to above, shows that some variability is to be expected, and that phylogenetic relationships are more meaningful when a conjunction of characters is analyzed (e.g. those of the reproductive system).

Lack of juvenile material prevented observation of the protoconch of *P. colmani*, for *Pythia* species exhibit decollation of the protoconch early in their growth stages (Harry, 1951).

Pythia colmani has assumed a completely terrestrial habitat, for it was found at an altitude of 100 m, in rainforest. The terrestrial habits of the species of *Pythia* have been well noted before (Morton, 1955), but they have not previously been recorded this far inland. Perhaps the development of the pallial organ is related to this complete terrestriality.

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Abbreviations used in the figures

a, posterior opening to the digestive gland; aa, cerebro-pleural connective; b, cardiac portion of stomach; bb, cerebro-pedal connective; c, anterior opening to the digestive gland; cc, pleural ganglion; ct, central radular tooth; d, intestine; dd, pleuro-pedal connective; e,oesophagus; ee, pleuro-parietal connective; f, pyloric portion of the stomach;ff, parietal ganglion; g, muscular band of mid-stomach; gg, parieto-visceral connective; h, gastric caecum; hh, visceral ganglion; i, first posterior mucous gland; ii, pedal ganglion; j, albumen gland; jj, pedal commissure; k, seminal vesicle; kk, sub-pedal commissure; l, second posterior mucous gland; ll, statocyst; m, anterior mucous gland; n, bursa; o, duct of bursa; p, prostate; q, pallial gland; r, vagina; s, opening to seminal groove; sl, shell length; t, female genital opening; u, anterior vas deferens; v, penial complex; w, penial retractor muscle; x, penis; y, cerebral commissure; z, cerebral ganglion;

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Redescription of *Fastosarion superba* (Cox, 1871), with descriptions of two new species of *Fastosarion* from northern Queensland (Pulmonata: Helicarionidae)

Bronwen Scott[1]

Museum of Tropical Queensland
70 – 84 Flinders Street
Townsville, Queensland 4810

1. Current address: Department of Zoology, James Cook University of North Queensland, Townsville, Queensland 4811

Fastosarion Iredale, 1933 is diagnosed. The reproductive anatomy of each of the following species is described and figured: *Fastosarion superba* (Cox, 1871) (type species of *Fastosarion*) from Mt Dryander and Clarke Range, between Bowen and Mackay, *Fastosarion helenkingae* sp. nov. from Mt Elliot, near Townsville, and *Fastosarion aquavitae* sp. nov. from Brandy Creek, near Proserpine, Queensland.

Keywords: Helicarionidae, *Fastosarion*, redescription, new species

Introduction

Semi-slugs of the family Helicarionidae are common in forests along the eastern coast of Australia. The taxonomy of the group is poorly known. Early descriptions were based largely on shell characters, but the shells of the helicarionid semi-slugs lack many of the characters present in typical helicoid shells and thus gross characters are of little use in species-level taxonomy. Anatomical studies are necessary to elucidate relationships within the Australian Helicarionidae.

Previous investigations on Australian forms include anatomical studies of *Helicarion* Férussac, 1821, from southeastern Australia (Kershaw, 1979, 1981), and *Thularion* Stanisic, 1993, *Eungarion* Stanisic, 1993, *Maladena suturalis* (Odhner, 1917) and *Sitala wilcoxi* (Cox, 1865) from northeastern Australia (Stanisic, 1993a, 1993b; Odhner, 1917).

Specimens of undescribed helicarionids collected at Mt Elliot, near Townsville, and Brandy Creek, near Proserpine, North Queensland, were distinguished from each other and from species of *Helicarion* and other helicarionid semi-slugs on the basis of reproductive anatomy. Examination of specimens of *Fastosarion superba* (Cox, 1871) from Mt Dryander, Mt Macartney, and Eungella, showed these new species, described here, to be congeneric. In order to describe the two new species, it was necessary to first clarify the genus *Fastosarion* Iredale, 1933.

Materials and methods

Material of an undescribed helicarionid was collected during survey work by the

Queensland Department of Environment and Heritage (QDEH) from Mt Elliot (Bowling Green Bay National Park)(19°30'S, 146°58'E). Live specimens were deposited in the Museum of Tropical Queensland, where they were killed by freezing (Scott, 1991), then fixed and preserved in 70% ethanol. Other material was held in the collections of the Queensland Museum, Brisbane.

Type material of *Vitrina superba* was not in the Australian Museum with other types designated by Cox. Smith (1992: 232) recorded the types as "status and whereabouts unknown, presumed lost", and this was confirmed by a search of the collection. However, wet topotypic material from Mt Dryander was examined, as well as specimens from Mt Macartney and Eungella (approximately 100km south of the type locality).

Descriptions of shell and body colour follow Smithe (1975). Descriptions of reproductive tract anatomy follow Quick (1960) and Stanisic (1993a, 1993b).

Systematics

Genus *Fastosarion* Iredale, 1933

Type species: *Vitrina superba* Cox, 1871 by original designation.

Helicarion (Fastosarion) Iredale, 1933: 37. Zilch (1959): 309.

Fastosarion Iredale, 1937: 9. Burch, 1976: 134. Smith, 1992: 231.

Diagnosis: Large to very large semi-slug. Dart sac absent. Vagina present. Spermatheca short. Epiphallus with sinuate flagellum at junction with vas deferens. Caecum near insertion of penial retractor muscle. Penis with pilaster, penis lining ornamented with ridges or papillae.

Description:

External appearance: Animal light to dark neutral grey in alcohol. Body long, with tail produced into caudal horn. Lateral edges of mantle extended into left and right pallial lappets which cover shell, and right body lappet superior to pneumostome. Sole tripartite, neutral grey to beige in alcohol.

Shell (Figs. 1, 2): Pale horn to yellow ochre, glossy, fragile. Protoconch iridescent, with sculpture of fine radial ribs; teleoconch with growth lines and very fine radial ribs. Whorls 2.8 – 3.5, body whorl depressed and increasing rapidly. Spire depressed, sutures moderately impressed. Aperture large, roundly ovate. Umbilicus narrow.

Reproductive tract: (Figs 3, 4, 5) Albumen gland rounded, compact. Hermaphroditic duct tightly coiled. Uterus and prostate joined. Free oviduct swollen at junction with vagina. Free oviduct 75% length of vagina. Spermathecal shaft short, spermathecal head swollen, rounded. Vagina swollen, short, less than 20% length of penis/epiphallus complex. Vas deferens coiled proximally, straight distally.

Broad sinuate epiphallic flagellum at junction of vas deferens and epiphallus. Caecum at bend in epiphallus at point of insertion of penial retractor muscle. Epiphallus thin, long, approximately 150% length of penis. Penis thin, long, surrounded by collar-like penis sheath, which is unattached proximally, but inserted on

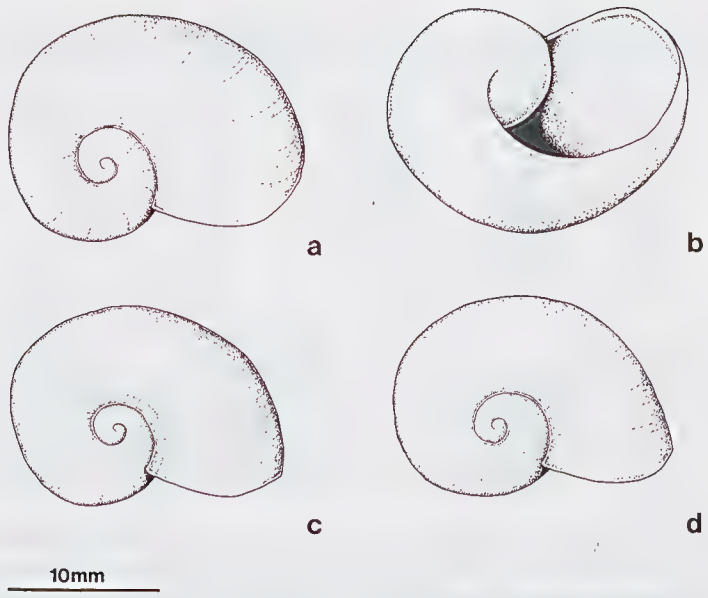

Figure 1. Shells of *Fastosarion*: a, b, shell of *F. superba* (Palm Walk, Eungella); c, shell of *F. helenkingae* sp. nov. (Mt Elliot); d, shell of *F. aquavitae* sp. nov. (Brandy Creek).

genital atrium distally. Penis with pilaster and small verge at junction with epiphallus.

Status of the genus *Helicarion* (type species: *Vitrina superba* Cox, 1871)

Iredale (1933) established *Fastosarion* as a subgenus of *Helicarion* based on size and shell characters, but suggested anatomical studies might result in further separation. He later (Iredale, 1937) raised *Fastosarion* to generic level. The subsequent systematic treatment of *Fastosarion* has been variable. Baker (1941) synonymised *Fastosarion* with *Helicarion*. Zilch (1959) supported Iredale's original decision on placing *Fastosarion* as a subgenus of *Helicarion* (Iredale, 1933). Burch (1976) followed Iredale (1937) and listed *Fastosarion* as a full genus. Smith (1992) synonymised *Vercularion* Iredale, 1933, with *Fastosarion*, and included eight species, most of which were previously placed in *Helicarion*.

The present study showed differences in the reproductive anatomy of *F. superba* and *H. cuvieri*, the type species of *Helicarion*, which are considered robust enough to support *Fastosarion* as a separate genus.

Fastosarion is difficult to distinguish from *Helicarion* and other genera of semi-slugs on external characters other than size. Two features of the reproductive tract separate *Fastosarion* and *Helicarion*: *Fastosarion* has a well-developed vagina and a caecum near the retractor muscle. Both are absent in *Helicarion* (Kershaw, 1979, 1981).

Although Kershaw (1979, 1981) and Dartnall and Kershaw (1978) recorded the presence of a vagina in four species of *Helicarion*, their interpretation of this structure does not follow that of Quick (1960), in which the vagina is the section of the female tract between the genital atrium and the duct of the spermatheca (bursa copulatrix of Dartnall and Kershaw, 1978; Kershaw, 1979, 1981). If the spermathecal duct has its origin at the genital atrium, then the vagina is lacking (Quick, 1960). Illustrations of

Table 1: Comparative reproductive anatomy of selected genera of northeastern Queenslan helicarionids (data from this study, Kershaw, Stanisic, 1993a, b; Odhner, 1917)

	Fastosarion	*Helicarion*	*Thulārion*	*Eungarion*	*Malandena*	*Sitala*
vagina	present	absent	present	present	present	presen
spermatheca	short	short	medium	short	?	short
flagellum	sinuate	small	long, straight	sinuate	long, straight	absent
caecum	present	absent	present	present	absent	absent
dart sac	absent	absent	absent	absent	present	presen

the four species of *Helicarion* indicate that the duct of the spermatheca opens at th genital atrium (Dartnall and Kershaw, 1978; Kershaw, 1979, 1981), and thus th vagina of *Helicarion* is absent. In *Helicarion* the main element of the distal femal genitalia is the free oviduct. There is a distinct vagina in *Fastosarion*, which is longe than the free oviduct.

The differences between *Fastosarion* and *Eungarion* appear less pronounced tha those between *Fastosarion* and *Helicarion*. Stanisic (1993b) lists differences in size o animal, shell structure, penial sculpture and number of penial pilasters between th two genera. Characteristics such as the presence of a well-developed vagina and caecum near the penial retractor muscle are shared.

Fastosarion can be distinguished from *Thulārion* by the shape of the shell, enlarge mantle lappets, length of the spermatheca, shape of the flagellum, and penial sculptur (Stanisic, 1933a).

Differences between *Fastosarion* and other north-eastern Australian genera ar summarised in Table 1.

Fastosarion superba (Cox, 1871)

(Figs 1a, 1b, 2, 3, 4, 5a, 6)

Vitrina superba Cox, 1871: 54. Mt Dryander, Port Denison, Queensland. Cox, 1888 1063, pl. xxi, figs. 8–9.

Helicarion (Fastosarion) superba Iredale, 1933: 37.

Fastosarion superba Iredale, 1937: 9. Smith, 1992: 232.

Material examined: Mt Dryander (20°15'S, 148°33'E): 4 live adults, MVF–NVF *Araucaria* – NVF/palms, in discarded palm fronds, collected by J. Stanisic, D. Potter 6.vii.1983 (QM MO31289). Mt Macartney (20°50'S, 148°33'30"E): 15 live adults an juveniles, slopes of Mt Macartney, Cathu State Forest drive, alt. 900m, NVF/tree ferns in palm fronds, collected by J. Stanisic, D. Potter, N. Potter, 18.v.1990 (QM MO35627). Eungella National Park (21°08'S, 148°32'E): Palm Walk, 16 live adult and juveniles, Palm Walk, inactive in rolled-up palm frond stems, collected by B.J Scott, J. Seymour, C. Lokkers, 4.x.1988 (MTQ MO40192).

Diagnosis: Very large semi-slug. Penis sheath equal in length to penis. Penial pilaste with parallel V-shaped transverse ridges continuing on rest of lining (Fig. 5a).

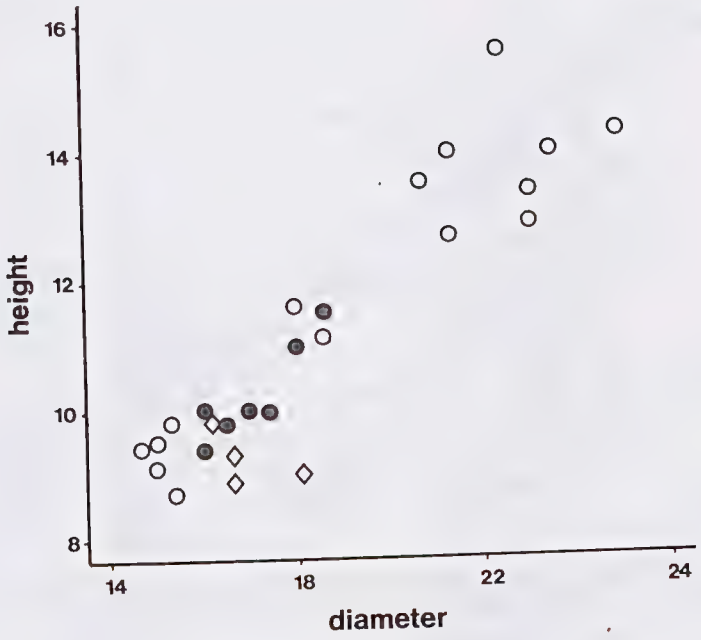

Figure 2. Comparison of shell sizes between *Fastosarion superba* (○), *F. helenkingae* sp. nov. (●), and *F. aquavitae* sp. nov. (◊).

Description:

External appearance: Animal light to dark grey in alcohol, usually with beige suffusion. Left and right pallial lappets darker than right body lappet and mantle. Sole tripartite, beige in alcohol.

Shell: (Fig. 1a, 1b, 2). Colour pale horn to yellow ochre, glossy, fragile. Height from 8.7 – 15.6 mm (mean 12.7 mm), diameter from 14.7 – 24.9 mm (average 21.0 mm), H/D from 0.56 – 0.7 (mean 0.6). Protoconch iridescent, with sculpture of fine radial ribs; teleoconch with growth lines and very fine radial ribs. Whorls 2.7 – 3.3, body whorl depressed and increasing rapidly. Spire depressed, sutures moderately impressed. Aperture large, roundly ovate. Umbilicus narrow. Data from 14 adults.

Reproductive tract: (Figs 3, 4, 5a). As for genus. Spermathecal shaft short, spermathecal head swollen, rounded. Epiphallus thin, long, approximately 150% length of penis. Penis thin, long, surrounded by collar-like penis sheath, which is unattached proximally, but inserted on genital atrium distally. Penis sheath equal in length to penis. Penis lining with numerous parallel V-shaped ridges and ridged pilaster (Fig. 5a).

Range: Mid-east Queensland: Mt Dryander to Clarke Range (Fig. 6).

Habitat: Mesophyll and notophyll vine forest, with palms.

Discussion: Although the type material of this species has not been located and appears to be either lost or destroyed, no neotype has been designated for this species. Neotypes

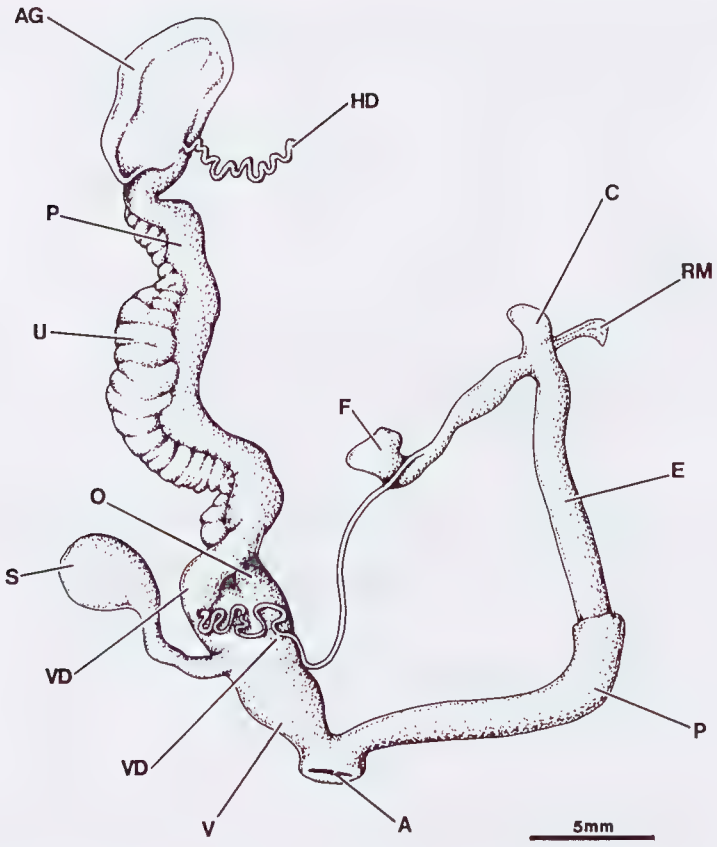

Figure 3. Reproductive tract of *Fastosarion superba* (Palm Walk, Eungella) (A, genital atrium; AG, albumen gland; C, epiphallic caecum; E, epiphallus; F, epiphallic flagellum; HD, hermaphroditic duct; O, free oviduct; P, penis; PR, prostate; PRM, penial retractor muscle; S, spermatheca; U, uterus; V, vagina; VD, vas deferens)

are only to be designated under 'exceptional circumstances' (ICZN, 1985: 157), to define species-group taxa whose identities may be confused or doubtful. *Vitrina superba* Cox, 1871, does not meet the criteria for the selection of new type material.

Cox (1871) described *Vitrina superba* as the largest species of *'Vitrina'*. It is the largest helicarionid in mid-east Queensland, and individuals from Mt Dryander, the type locality, may exceed 8cm in length. Size and coloration varies between populations, but individuals from different populations are indistinguishable on the basis of reproductive anatomy.

Fastosarion superba occurs with *Eungarion mcdonaldi* Stanisic, 1993, at Eungella (Stanisic, 1993b), and probably extends further south along the Clarke Range. It has not been recorded from the Conway Range, despite frequent collecting in the lowland vine forests. *Fastosarion superba* is active at night, but at Mt Dryander and other localities may be found during the day in rolled-up palm leaves.

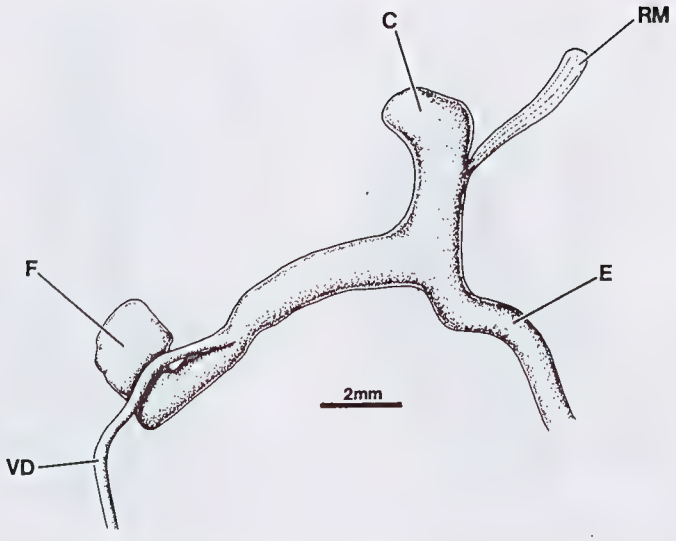

Figure 4. Epiphallic caecum of *Fastosarion superba* (Palm Walk, Eungella) (C, epiphallic caecum; F, epiphallic flagellum; PRM, penial retractor muscle; VD, vas deferens)

Fastosarion helenkingae sp. nov.

(Figs 1c, 2, 5b, 6)

Holotype: Bowling Green Bay NP, Mt Elliot (19°30'S, 146°58'E): rainforest, 900m, 12–18/xii/1990, collected by A. Graham (MTQ MO40184). Shell dimensions: height 11.5 mm, diameter 18.6 mm, H/D 0.62.

Paratypes: Bowling Green Bay NP, Mt Elliott (19°30'S, 146°58'E): 6 live adults, same collection details as holotype (MTQ MO40185–40191).

Etymology: This species is named for Helen King, former Curator of Malacology at the Queensland Museum, Brisbane.

Diagnosis: Medium semi-slug. Shell gold with depressed spire. Pilaster with transverse ridges breaking up into regular high, flattened, pointed papillae on lining (Fig. 5b).

Description:

External appearance: Animal light to dark neutral grey in alcohol. Lappets and mantle same colour as body. Sole tripartite, pale neutral grey with light neutral grey border in alcohol.

Shell: (Figs. 1b, 2). Colour pale horn to yellow ochre, glossy, fragile. Height from 9.4 – 11.5 mm (mean 10.24 mm), diameter from 16.0 – 18.6 mm (average 17.07 mm), H/D from 0.575 – 0.62 (mean 0.6) (Table 2). Protoconch iridescent, with sculpture of fine radial ribs; teleoconch with growth lines and very fine radial ribs. Whorls 3.2 – 3.5, body whorl depressed and increasing rapidly. Spire depressed, sutures moderately impressed. Aperture large, roundly ovate. Umbilicus narrow. Data from 7 adults.

Reproductive tract: (Fig. 5b). As for genus. Spermathecal shaft short, spermathecal

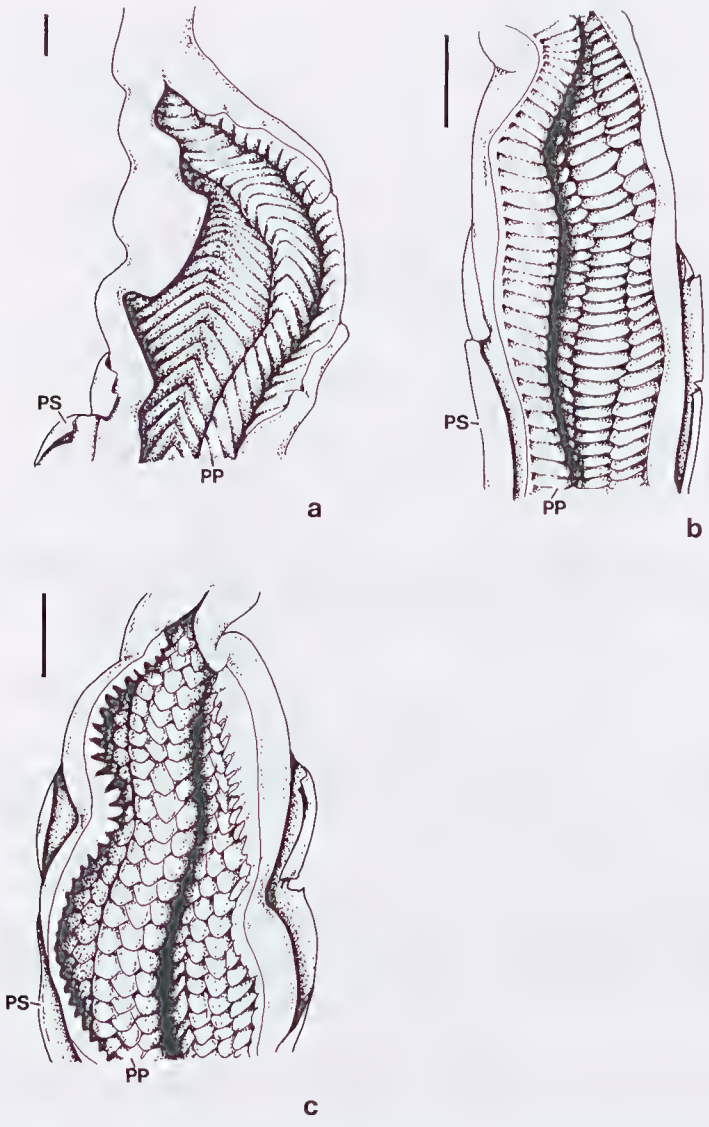

Figure 5. Penial lining: a, *Fastosarion superba* (Mt Dryander); b, *F. helenkingae* sp. nov. (holotype, Mt Elliot); c, *F. aquavitae* sp. nov. (holotype, Brandy Creek) (E, epiphallus; P, penis; PS, penis sheath) (scale bar = 1mm)

head swollen, elongate. Epiphallus thin, long, approximately 150% length of penis. Penis thin, long, surrounded by collar-like penis sheath, which is unattached proximally, but inserted on genital atrium distally. Penis sheath approximately 50% of length of penis. Penis pilaster with transverse ridges breaking up into regular high, flattened, pointed papillae on lining (Fig. 5b)

Range: North-east Queensland: Mt Elliot (Fig. 6)

Habitat: Notophyll vine forest on granite, above 900 m.

Table 2: Shell dimensions of type series of *Fastosarion helenkingae* sp. nov.

	height (mm)	diameter (mm)	H/D
Holotype	11.5	18.6	0.618
Paratypes	11.0	18.0	0.611
	10.0	17.4	0.575
	10.0	17.0	0.588
	10.0	16.1	0.621
	9.8	16.4	0.597
	9.4	16.0	0.587

Discussion: *Fastosarion helenkingae* can be separated from *Fastosarion superba* and *F. aquavitae* by the penial sculpture (Fig. 5b).

This species is known only from a small area of upland vine forest south of Townsville, but subsequent collecting in suitable areas may extend the range. Helicarionids have been reported from gullies on Herveys Range, W of Townsville, but no specimens have been examined.

Fastosarion aquavitae sp. nov.

(Figs. 1d, 2, 5c, 6)

Holotype: Conway Range, Brandy Creek Road (20°20'30"S, 148°39'30"E), edges of Brandy Creek, riverine rainforest, in discarded palm fronds, 15.v.1990, collected by J. Stanisic, D. Potter, N. Potter. Shell dimensions: height 9.9mm, diameter 16.2mm, H/D 0.61 (QM MO55782).

Paratypes: Conway Range, Brandy Creek Road (20°20'30"S, 148°39'30"E), 6 live adults, same collection details as holotype (QM MO35370).

Etymology: The specific epithet (*aquavitae* L. = 'water of life') refers to the type locality, Brandy Creek.

Diagnosis: Medium semi-slug. Shell gold with depressed spire. Penis lined with irregular high, flattened, pointed papillae. Pilaster with staggered papillae (Fig. 5c).

Description:

External appearance: Animal pale neutral grey in alcohol. Lappets and mantle same colour as body, with black patch above pnuemostome. Sole tripartite, pale neutral grey with light neutral grey border in alcohol.

Shell: (Figs. 1d, 2). Colour pale horn to yellow ochre, glossy, fragile. Height from 8.9 – 9.9 mm (mean 9.15 mm), diameter from 16.2 – 18.1 mm (average 16.7 mm), H/D from 0.5 – 0.61 (mean 0.55) (Table 2). Protoconch iridescent, with sculpture of fine radial ribs; teleoconch with growth lines and very fine radial ribs. Whorls 2.8 – 3.0, body whorl depressed and increasing rapidly. Spire depressed, sutures moderately impressed. Aperture large, roundly ovate. Umbilicus narrow. Data from 4 adults.

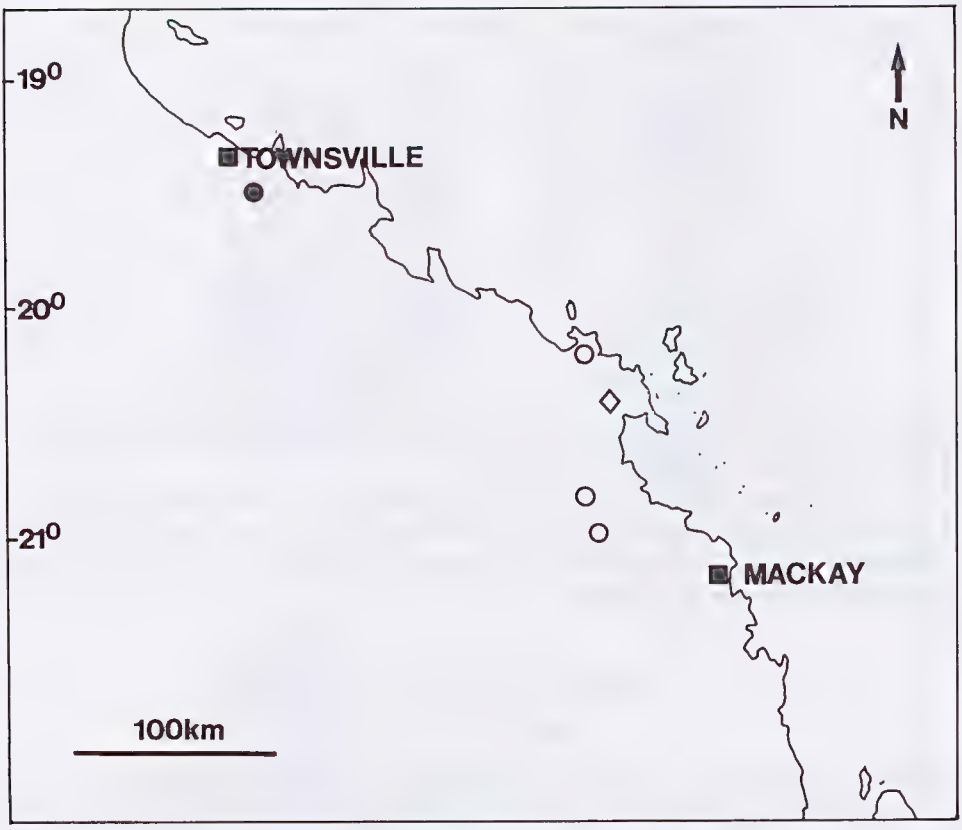

Figure 6. Distribution of *Fastosarion superba* (○), *F. helenkingae* sp. nov. (●), and *F. aquavitae* sp. nov. (◊).

Reproductive tract: (Fig. 5c). As for genus. Spermathecal shaft short, spermathecal head swollen, elongate. Epiphallus thin, long, approximately 140% length of penis. Penis thin, long, surrounded by collar-like penis sheath, which is unattached proximally, but inserted on genital atrium distally. Penis sheath approximately 50% of length of penis.

Penis lined with irregular high, flattened, pointed papillae. Pilaster with staggered papillae (Fig. 5c)

Range: Mid-east Queensland: Brandy Creek, Conway Range (Fig. 6)

Habitat: Riverine rainforest.

Discussion: *Fastosarion aquavitae* can be separated from *Fastosarion superba* and *F. helenkingae* by penial sculpture (Fig. 5c). Like the other two species of *Fastosarion* in mid-east Queensland, its range does not overlap with that of any known congener. It appears to be the only large semi-slug in the Conway Range (J. Stanisic, pers. comm.), but much of the range is poorly known and further collecting may reveal other species.

Table 3: Shell dimensions of type series of *Fastosarion aquavitae* sp. nov.

	height (mm)	diameter (mm)	H/D
Holotype	9.9	16.2	0.611
Paratypes	9.3	16.7	0.556
	9.0	18.1	0.497
	8.9	16.7	0.532

Acknowledgements

Thanks to Alastair Graham (Queensland Department of Environment and Heritage) who collected the specimens used in this study, and to Dr John Stanisic (Queensland Museum) who provided specimens and constructive criticism. Special thanks go to Keith McDonald (QDEH) who provided advice and encouragement at all stages of this and other rainforest snail projects. This is publication no. 6 from the Museum of Tropical Queensland.

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Moll. Res. 16: 81–95 (1995).

The Recent Spondylidae of South Africa and Mozambique, with the description of a new species (Mollusca, Bivalvia, Pectinoidea)

Kevin L. Lamprell
Queensland Museum
PO Box 3300
South Brisbane, Queensland 4101, Australia

and

Richard N. Kilburn
Natal Museum
Private Bag 9070
Pietermaritzburg 3200, South Africa

Ten species of the genus *Spondylus* are recorded from South Africa and Mozambique (6 from South Africa, 9 from Mozambique). Of these, only *Spondylus nicobaricus* Schreibers, 1793, has been repórted previously. *Spondylus groschi* from Mozambique and Natal is described as new. The remainder are widely distributed Indo-Pacific taxa: *Spondylus cuneus* Reeve, 1856, *Spondylus sinensis* Schreibers, 1793, *Spondylus occidens* Sowerby, 1903, *Spondylus sanguineus* Dunker, 1852, *Spondylus castus* Reeve, 1856, *Spondylus butleri* Reeve, 1856, *Spondylus flabellum* Reeve, 1856, and *Spondylus tenuispinosus* Sowerby, 1847.

Key words: Mollusca, Bivalvia, Spondylidae, *Spondylus,* new species, South Africa, Mozambique

Introduction

Published records of the family Spondylidae from South Africa and Mozambique are sparsely scattered through the literature. The first South African record of the genus *Spondylus* dates from Sowerby (1897: 28) who recorded *Spondylus nicobaricus* ("Chemnitz") Schreibers, 1793, and *S. ducalis* ("Chemnitz") Röding, 1798, from Natal. The latter record has never been confirmed, and is presumed to be erroneous. Barnard (1964) accepted the occurrence of only *S. nicobaricus* (as *Spondylus hystrix* Röding, 1798).

The first records of *Spondylus* from Mozambique were published by Braga (1952), who recorded *S. nicobaricus* and also *S. microlepos* Lamarck, 1819; Paes da Franca (1960) reported the same two species. Boshoff (1965) regarded Mozambican records of *microlepos* as being based on *S. regius* (Linnaeus, 1758). However, no trace of that distinctive species has been reported from the south-western Indian Ocean, and the material in question was probably *S. sinensis* Schreibers, 1793. (The primary collection of Inhaca bivalves on which Boshoff based this record was destined for the Estação de

Biologia Maritima de Inhaca, but cannot now be located; his duplicate collection, deposited in the Natal Museum, contains only *S. nicobaricus*.)

Although not concerning the Recent fauna, it may also be mentioned that Barnard (1964: 436, fig. 15) recorded a broken valve from limestone deposits at Klein River (southern Cape Province, Overberg area) as "*Spondylus* sp." The material is probably referable to *Hinnites ercolianus* (Cocconi, 1873), a West African species of the family Pectinidae whose present range appears to extend to northern Namibia.

This is the first study of the spondylid material from South Africa and Mozambique housed in the Natal Museum. Examination of this material has revealed the presence of one previously undescribed species of *Spondylus* from the region and eight previously unrecorded species.

Abbreviations: KL, Lamprell collection; lv, left valve (upper or top valve); leg, collector; LT, Low Tide; LST, Low Spring Tide; NM, Natal Museum; NMDP, Natal Museum dredging programme; NPB, Natal Parks Board; ORI, Oceanographic Research Institute; pv, paired valves; QM, Queensland Museum; rv, right valve (lower valve).

Systematics

Family Spondylidae Gray, 1826

Spondylus Linnaeus, 1758 Type species *Spondylus gaederopus* Linnaeus, 1758.

Key to *Spondylus* in South Africa and Mozambique

1. Radial ribs with spines very short or absent, outline fan-shaped 2
   Radial ribs with well developed spines; outline rarely fan shaped 3
2. Radial ribs uniform in strength; cardinal area with 2 or more brown stripes diverging from umbones; shell small, to 50mm in height ..... *S. sanguineus*
   Radial ribs very uneven in strength, cardinal area without stripes; shell large, to 110mm in height ..... *S. flabellum*
3. Upper (left) valve with 5–7 principal ribs and spatulate spines 4
   Upper (left) valve with numerous rows of ribs and dense spines 5
4. Upper valve with 6–7 principal ribs with numerous, overlapping, spatulate spines ..... *S. groschi*
   Upper valve with 5–6 principal ribs with sparse, spatulate and/or pointed spines ..... *S. sinensis*
5. Spines non-spatulate 6
   Spines sharp to blunt, erect 7
6. Spines curved, not depressed; shell colour black-brown, spines purple, yellow or orange; shell large, to 80mm in height ..... *S. butleri*
   Spines straight, depressed; shell colour white with black spotting extending into rib intervals; shell medium, to 50mm in height ..... *S. castus*

7. Spines blunt, rarely erect; short to long 8
   Spines sharp, erect, short 9
8. Spines denser and overlapping each other marginally; interstitial areas smooth; purple-brown ..... *S. cuneus*
   Spines spatulate marginally; interstitial areas with dense sharp upright spines and striae; rose coloured ..... *S. tenuispinosus*
9. Interstices with radial striae and minute spines; umbonal region white with regular rows of dark spots ..... *S. nicobaricus*
   Interstices smooth; umbonal region not dark spotted ..... *S. occidens*

Spondylus groschi sp.nov.
Figure 1A–C

Diagnosis: Shell ovate, thick. Hinge typical for genus. Top (left) valve moderately and evenly convex; interior slightly excavated under hinge plate, with a strong, coloured crenulated margin; auricles moderately wide, umbonal margins denticulate. Sculpture consisting of 6–7 well-defined, principal radial ribs, bearing strong, depressed, overlapping, spatulate spines which are hollowed on their underside, only slightly narrower at their base, moderately concave at their termination, almost obsolete umbonally; young specimens often develop palmate ends to spatulate spines near lower margin. Each rib interval usually with one secondary radial rib ornamented with sharp or slightly flattened, overlapping spines, the remaining interstitial surface covered with dense radial striae and fine, fairly sharp spines, varying in length; however (rarely) in some young specimens the interstitial ornamentation is of equal strength to the principal ribs. Lower (right) valve more convex than top valve, some senile specimens much more convex than younger specimens; cardinal area triangular and shallow; internally with moderate, shallow excavation under hinge plate and a strong, coloured, crenulated margin. Fixation area small, sometimes with a variable amount of thin concentric foliations umbonally; sculpture on non-attached part similar to that of top valve. Colour mauve-brown with white at base of spines, or orange, orange red or deep brick-red, main spines sometimes contrastingly yellowish or lilac-coloured; umbonal region often with irregular brown spots, blotches or undulating marks; internally white, with the margins coloured the same as the external surface.

Type locality: SE Conducia Bay, Mozambique.

Material examined: Holotype: 1pv, NM-H164/T1000, SE Conducia Bay, north of Inhaca, Mozambique Province, E side of reef, edge of rock, current, LST, K. Grosch, Nov 1967.

Paratypes: Northern Mozambique: 1pv, NM-H161/T1001, Mozambique Island, south shore, on outer edge, rocky ledge above coral area, LST, K. Grosch, Nov 1958; 1pv, NM-H166/T1002, Conducia Bay, Mozambique Province, K. Grosch, Nov 1975; 1pv, QM MO52425, south east Memba Bay, south west of Ponta Nangata, Mozambique Province, on rock near coral area, some surf, LST, K. Grosch, Nov 1975; 1pv, NM-H159/T1003, SW Conducia Bay, north of Chocas, Mozambique Province, washed up

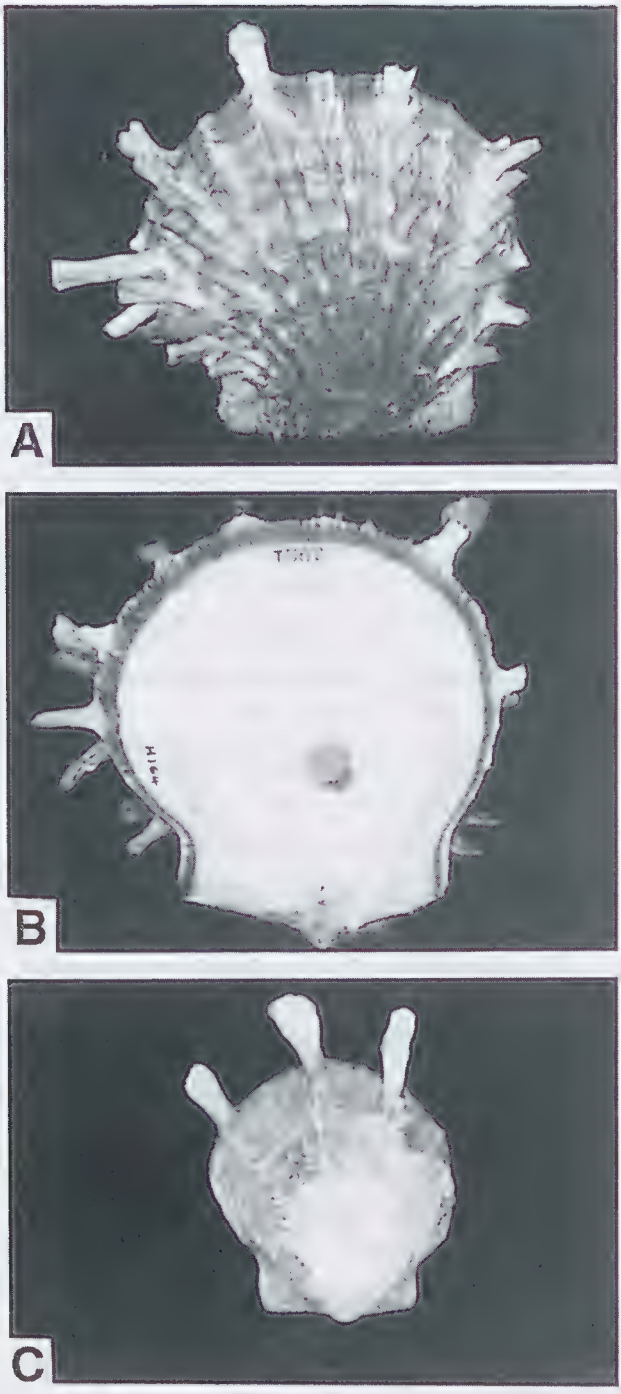

Fig 1. *Spondylus groschi* n. sp. A-B, Holotype, NM-H161, Conducia Bay, Mozambique, height 77.5 mm, length 77.4 mm; C. NM-E3651, off Gypsy Hill, Zululand, 65-70 m, height 12.3 mm, length 11.6 mm, juv. Measurements exclude spines.

during cyclone, K. Grosch, Dec 1951; 1pv, NM-H167/T1004, SE Lunga Bay, Mozambique Province, on rock near coral reef, current, some surf, LST, K. Grosch, Sept 1975; 1pv, NM-H163/T1005, Conducia Bay, Mozambique Province, K. Grosch, Sept 1975.

Other material: Northern Mozambique: 1pv, NM-H168, SW Conducia Bay, W of Is. Inhaca Grande, on underside of rock slab in tidal pool, LST, K. Grosch, Oct 1968; 1pv, NM-H171, SW Conducia Bay, NW of Chocas, on edge of rocky shelf, no surf, 0.7 m below LST, K. Grosch, Apr 1961; 1pv, NM-H172, SE Conducia Bay, W. coast of Is. Inhaca Grande, on encrusted rock in tidal pool, LST, K. Grosch, Oct 1968; 1pv, NM-H170, SW Conducia Bay, N of Chocas, washed up during cyclone, K. Grosch, Apr 1954; 1pv, NM-H169 SW Conducia Bay, NW of Chocas, on rocky reef, 0.7m below LST, K. Grosch, Sept 1962; 1pv, NM-H162, Conducia Bay, K. Grosch; 1pv, NM-H165, SE Nacala Bay, E of Fern Velosa, edge of rock above coral area, some surf, LST level, K. Grosch, Jan 1958; 1pv, NM-H160, SE Memba Bay, SW of Ponta Nangata, on rock near coral area, some surf, LST, K. Grosch, Jun 1960. South Africa: Zululand: 1lv, NM-D5195, Sodwana Bay, Two-Mile Reef, 10–15m, dived, D. Herbert, Oct 1986; 1lv, NM-D5096, Sodwana Bay, Two-Mile Reef, outer edge, 14–17m, dived, D. Herbert, Oct 1986; 2lv, NM-E809, Sodwana Bay, sponge reef, 33m, dived, D. Herbert & NPB, Sept 1987; 1lv, NM-D1846, Sodwana Bay, Two-Mile Reef, 10–15m, dived, D. Herbert, Oct 1985; 1pv, NM-E2472, Leadsman Shoal, Raggie Reef, 1–2km N of Leven Point, 8–12 m, mixed algal and coral reef, dived, D. Herbert & NPB, May 1988; 1lv, NM-E2421, Leadsman Shoal, reef off wreck of Tamavo, 20–28m, D. Herbert & NPB, May 1988; 1lv, NM-S1038, Kosi Bay, main reef, 1–4km S of estuary mouth, 18–20m, dived, D. Herbert & NPB, May 1990; 1lv, NM-4599, Bhanga Nek, c. 15 km S. of Kosi Bay, beach-drift, O. Bourquin, Jan 1965; 1pv, NM-S1785, between Bhanga Nek and Kosi Bay, reef off marker 13 north, 8–14m, D. Herbert & NPB, May 1990; 1lv, NM-D9594, between Bhanga Nek and Kosi Bay, No.13 reef, 6–18m, 12–20 Jul 1987, D. Herbert et al. 1lv, NM-E3651, off Gypsy Hill, Zululand, 65-70 m, NMDP. East Africa: Mombasa, Kenya: 1pv, KL, on reef low tide, 1993.

Measurements of holotype (excluding spines): Height 77.5mm (umbo to margin), length 77.4mm, depth (conjoined valves) 44.5mm.

Measurements of paratypes: NM-H161/T1001, height 58mm (umbo to margin), length 64.4mm, depth (conjoined valves) 35.7mm; NM-H166/T1002, height 43.5mm (umbo to margin), length 45.7mm, depth (conjoined valves) 26.1mm; NM-H159/T1003, height 50.8mm (umbo to margin), length 54mm, depth (conjoined valves) 31.8mm; NM-H167/T1004, height 35.5 mm(umbo to margin), length 34.4mm, depth (conjoined valves) 20.9mm; NM-H163/T1005, height 67.8mm (umbo to margin), length 70mm, depth (conjoined valves) 44.6mm.

Distribution: Zululand (Leadsman Shoal) to Mombasa, Kenya, East Africa.

Habitat: In coral reef areas, attached to rocks or corals, in more tropical areas from low tide (occasionally in pools) to <1m below, further south in about 8–28m depth.

Remarks: The species is generally constant in its sculpture, although paratype NM-H166, which is slightly juvenile, is more densely spined than normal and has more numerous principal ribs, each of which is ornamented with spatulate spines which are

wider at their termination. Some NM lots consist of beach-worn specimens, which have a similar rib count to the holotype, but display variation in shape from ovate or elongate-ovate to moderately fan-shaped.

Comparisons: *Spondylus groschi* resembles a number of species from the central Indo-West Pacific. It is closest in characters to *Spondylus violascens* Lamarck, 1819, which differs in having irregular ornamentation, lack of denticulate umbonal margins and narrower interstices that lack the dense spines of this species. *S. barbatus* Reeve, 1856, differs from *S. groschi* in possessing both sharp and spatulate spines, intermixed, on the principal ribs; of these the spatulate spines are mainly developed at the lower margins, while the interstices have sharp, short, upright spines; in addition, in *S. barbatus* the upper margins have colour bars which form a chevron pattern. *S. groschi* differs from *S. squamosus* Schreibers, 1793, principally in its having constant black and white radial rays, the presence of colour bars at the upper margins and the lack of denticulations to the margins. *S. sinensis* Schreibers, 1793, although similar in shape to *S. groschi*, differs in its greater inflation, longer principal spines, claw-like spatulae, much stronger interstitial ribs and much finer interstitial ornamentation. *S. imbutus* Reeve, 1856 (= *S. nux* Reeve, 1856), from the Philippines, differs from *S. groschi* in having 5 principal ribs which bear sparse, long, strongly incurved, leaf-shaped, fragile spatulae; the interstices bear fine minor ribs with microscopic striae, the auricles are narrow and devoid of denticulations.

Etymology: Named after Kurt Joachim Grosch (1912–1991), veteran Mozambique collector who provided most of the specimens used in this study.

Spondylus butleri Reeve, 1856

Figure 2A

Spondylus butleri Reeve, 1856: pl. 4, sp. 16; Fulton, 1915: 355, sp. 60; Lamprell, 1992: 192. Type locality: Philippine Islands.

Spondylus longitudinalis (non Lamarck,) Lamprell, 1986: 22, pl. 4, fig. 2.

Diagnosis: Shell height (left) valve to 75mm; top valve usually more inflated than the lower. Sculpture of numerous, fine, radial ribs which are ornamented with strong, depressed, sharp or slightly spatulate spines; interstices smooth, without sculpture. Colour variable, interstices dark brown, spines yellow, orange, red or brown; internally blue-white, inner crenulated margin dark-brown, outer margin purple-brown, hinge and margins near umbones light brown.

Material examined: Northern Mozambique: 1pv, NM-H357, SW Conducia Bay, N of Chocas, Mozambique Province, amongst marine growth on coral boulder, 3 m below LST, K. Grosch, Mar 1959; 1pv, NM-H354, Conducia Bay, Choca, coral area, washed up during cyclone, K. Grosch, Jan 1953. South Africa: Zululand: 1lv, NM-D7085, off Dog Point (27°06.6'S, 32°51.9'E), 50m, sandstone conglomerate, marine growths, dredged, NMDP, 4 Jun 1987; 2lv, 2rv, NM-D8811, off Dog Point (27°06.6'S, 32°51.9'E), 50m, sandstone conglomerate, marine growths, dredged, NMDP, 4 Jun 1987.

Distribution: Indo-Pacific to northern Zululand.

Habitat: On coral among marine growths to 3 metres.

Spondylus sinensis Schreibers, 1793

Figure 2B

Spondylus sinensis Schreibers, 1793: 154 (based on Chemnitz, 1784: 75, pl. 44, figs 461–462); Cox, 1928: 252; Lamy, 1938: 293 (references, synonymy); Lamprell, 1986:

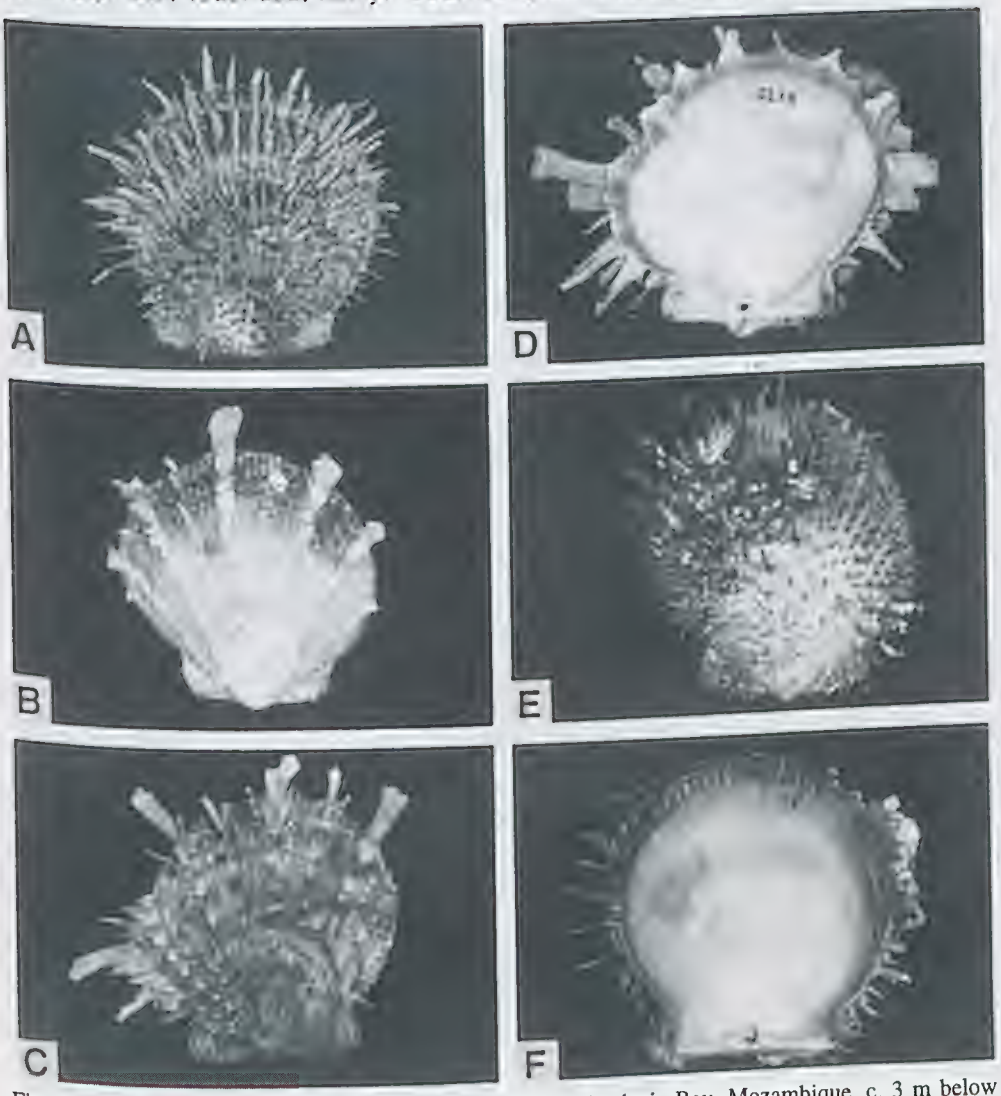

Fig 2. A, *Spondylus butleri* Reeve, 1856, NM-H357, Conducia Bay, Mozambique, c. 3 m below LST, height 93.3 mm, length 90.1 mm. B, *S. sinensis* Schreibers, 1793, NM-G3049, Conducia Bay, Mozambique, height 67.8 mm, length 67.9 mm. C, D, *S. semisplendens* Sowerby, 1847, NM-H175, Conducia Bay, Mozambique, height 53.2 mm, length 55.8 mm. E, F, *S. cancer* Reeve, 1856, NM-B9978, 1 km S. of Kosi Bay, Zululand, 20 m, height 66.1 mm, length 55.6 mm. Measurements exclude spines.

52 (synonymy), pl. 18, fig. 1A–E. Type locality: "China" (Chemnitz, 1784: 76).

Spondylus regius (non Linnaeus, 1758); Boshoff, 1965: 136.

Diagnosis: Shell height (left) valve, to 75mm; ovate, gibbous.

Sculpture of 5–6 principal ribs, ornamented with strong sparse spines, varying from pointed to spatulate (claw-like), some specimens have long spines while on others they are short and depressed; interstices are wide and have two or three broad ribs which usually bear dense minute spines. Colour variable, mauve-white to bright orange, internally white with a brightly coloured crenulated margin, brown at the hinge. Area of attachment small.

Material examined: Northern Mozambique: 1pv, NM-G3049, Conducia Bay, Mozambique Province, K. Grosch.

Distribution: Indo-West Pacific to northern Mozambique.

Habitat: Lives attached to corals or in coral sand.

Spondylus tenuispinosus Sowerby, 1847

Figure 2 C,D

Spondylus tenuispinosus Sowerby, 1847: 421, sp. 9, pl. 87, fig. 37; Reeve, 1856: pl.6, sp. 23; Fulton, 1915: 337, sp. 37; Lamy, 1938: 198 (references); Lamprell, 1986: 34, pl. 10, fig. 3. Type locality: Isle of Zebu, Philippines.

Diagnosis: Shell height (left) valve, to 35mm; oval, depressed. Sculpture of numerous radial striae and ridges are profusely spined with minute, sharp, erect spines, some longer marginally. Colour: white with circular bands of orange with rose staining; internally white with a variegated coloured crenulated margin. Area of attachment small.

Material examined: Northern Mozambique: 1pv, NM-H175, Conducia Bay, Mozambique Province, K. Grosch, Sept 1975. Southern Mozambique: 1pv, NM-H7415, Maputo, B.J.Young, Aug 1979.

Distribution: Central Indo-West Pacific to southern Mozambique.

Habitat: attached to dead corals.

Spondylus cuneus Reeve, 1856

Figure 2 E,F

Spondylus cuneus Reeve, 1856: pl. 15, sp. 56; Fulton, 1915: 332, sp. 8; Lamprell, 1986: 30 (synonymy), pl. 8, fig. 1a–d. Type locality: West Indies.

Diagnosis: Shell height (left) valve 70mm; oblong ovate. Sculpture of many irregular ridges, ornamented with numerous, regular, strong, slightly depressed, blunt spines of varying lengths; interstices usually smooth but minor spines do occur in some

specimens. Colour purple-red to brown, spines usually of a purple colour, internally white with a purple coloured crenulated margin.

Material examined: Northern Mozambique: 1pv, NM-H353, Conducia Bay, K. Grosch. South Africa: Zululand: 1pv, NM-B9978, 1ml S of Kosi Bay, 0.6ml offshore, 20m, under living coral, ORI, Dec 1984; 1lv, 1pv, NM-D9412, off Kosi Bay, main reef, 1.4km S of estuary, 9–17 m, D. Herbert & NPB, Jul 1987; 1pv, NM-D9369, off Kosi Bay, main reef, 1–2 km S of estuary, outer edge, 18–24 m, dived, D. Herbert & NPB, Jul 1987; 1lv, NM-E2423, Leadsman Shoal, reef off wreck of Tamavo, 20–28 m, dived, D. Herbert & NPB, May 1988.

Distribution: West Indies (Reeve), Central Indo-West Pacific to northern Zululand.

Habitat: On and under live corals in 9–30 m.

Remarks: The type locality of this species (West Indies) is in doubt, as there does not appear to be any recent record of *S. cuneus* from this now well-collected area. At the same time Reeve recorded *S. hystrix* (preocc. *S. hystrix* Röding, 1798) [= *S. cuneus*] from the Philippines (which Fulton unnecessarily renamed *S. reevei*, citing the same locality).

Spondylus sanguineus Dunker, 1852

Figure 3 A

Spondylus sanguineus Dunker, 1852: 55; Dunker, 1858: 26, sp. 22, pl. 7, figs 4–5; Iredale, 1939: 377; Lamprell, 1986: 72 (synonymy), pl. 27, figs 1A–C. Type locality unknown.

Diagnosis: Shell height (left) valve to 30mm; solid, fan-shaped. Sculpture of numerous fine, radial ribs which are ornamented with fine nodular spines, some small spines occur marginally. Colour burnt-brown, orange or white with radial rays of pink, cardinal area with 2 or more brown stripes diverging from under the umbones, internally white, external colour visible internally.

Material examined: South Africa: Zululand: 2pv, NM-B9492, between Bhanga Nek and Kosi Bay, Reef no. 13, drop-off at outer edge, 12–20m, D. G. Herbert & NPB, Jul 1987.

Distribution: Indo-West Pacific to northern Zululand.

Habitat: Lives attached to undersides of coral slabs, lower or right valve totally fixed to substrate.

Spondylus castus Reeve, 1856

Figure 3 B,C

Spondylus castus Reeve, 1856: pl. 13, sp. 47; Fulton, 1915: 334, sp. 19; Lamy, 1938: 273 (references); Lamprell, 1986: 26, pl. 6, fig. 3. Type locality: Philippine Islands.

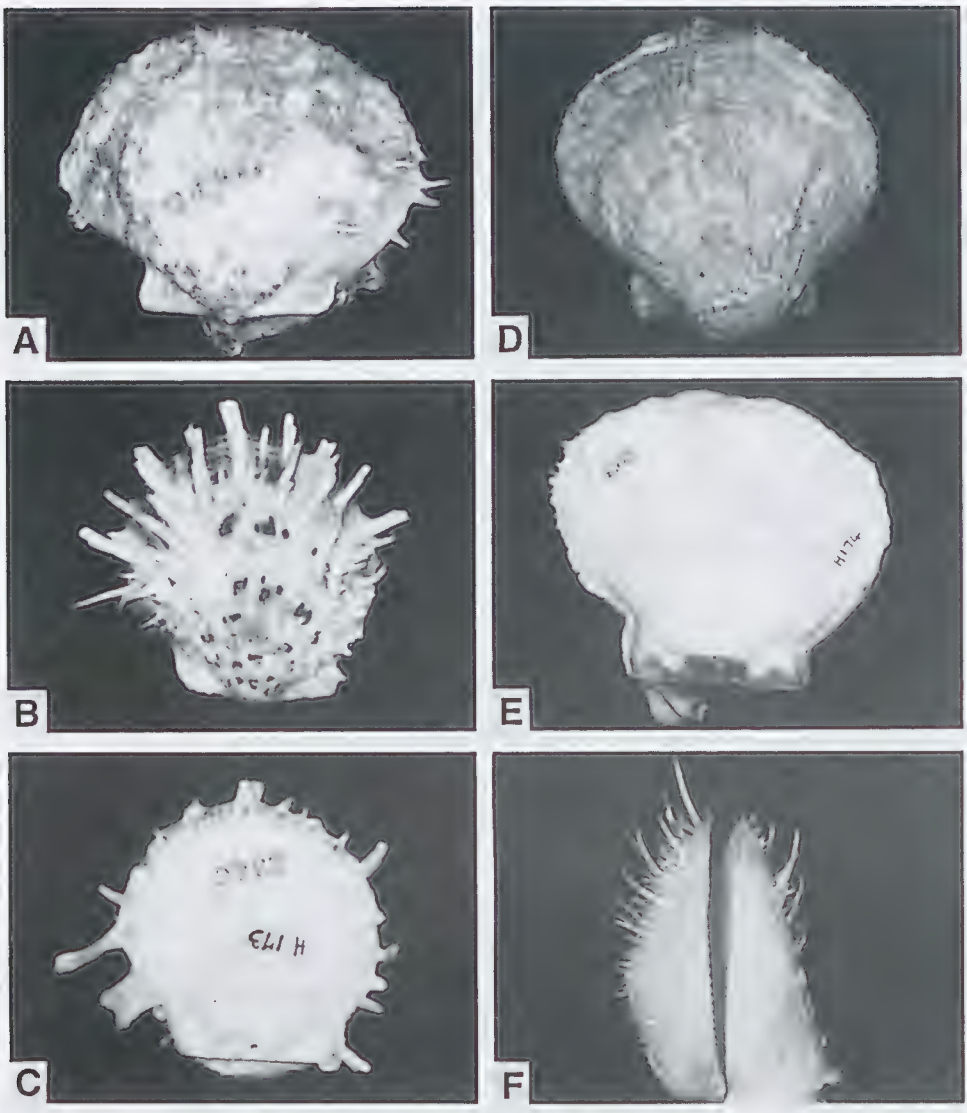

Fig 3. A, *Spondylus sanguineus* Dunker, 1852, NM-D9492, between Bhanga Nek and Kosi Bay, Zululand, 12-20 m, height 44.5 mm, length 52.8 mm. B, C, *S. castus* Reeve, 1856, NM-H173, Conducia Bay, Mozambique, reef, height 44.9 mm, length 46.8 mm. F, *S. occidens* Sowerby, 1903, NM-E3270, off Gypsy Hill, Zululand, 100-125 m, height 29.1 mm, length 30.0 mm. Measurements exclude spines.

Diagnosis: Shell height (left) valve to 50mm; ovate, depressed. Sculpture of numerous radial, striated ribs which are ornamented with long, thin, flat spines, depressed marginally. Colour: white with black spotting at the umbones; internally white, brown or orange at the crenulated margin. Area of attachment large.

Material examined: Northern Mozambique: 1pv, NM-H173, N of Chocas, SW Conducia Bay, Mozambique Province, on rock outside reef, current, some surf, LST level, K. Grosch, Sept 1975.

Distribution: Indo-West Pacific to northern Mozambique.

Habitat: Lives attached to rock or debris.

Spondylus flabellum Reeve, 1856

Figure 3 D,E

Spondylus flabellum Reeve, 1856: pl. 6, sp. 21, pl. 13, sp. 21b; Fulton, 1915: 359, sp. 78; Lamprell, 1986: 70, pl. 26, figs 2A–C. Type locality: unknown.

Diagnosis: Shell height (left) valve to 110m; broadly triangular, fan-shaped, slightly depressed. Sculpture of numerous irregular ridges, the principal ridges bear short thick spines, sometimes depressed while the spines are often obsolete. Colour varies from purple red to orange with some white areas, umbonally there is a consistent black pattern of vertical lines on a white area; internally white, crenulated margin coloured. Area of attachment large.

Material examined: Northern Mozambique: 1pv, NM-H174, N of Chocas, Conducia Bay, Mozambique Province, washed up from offshore reef during cyclone, K. Grosch, Sept 1975. South Africa: Zululand: 1pv, NM-B1644, Cape Vidal, B.J. Young, Aug 1979.

Distribution: Indo-West Pacific to Zululand.

Habitat: Lives attached to corals and in loose coral sand.

Spondylus occidens Sowerby, 1903

Figure 3 F; 4 A,B

Spondylus occidens Sowerby, 1903: 77, pl. 5, fig. 9; Fulton, 1915: 359, sp. 77; Lamprell, 1986: 36, pl. 11, figs 1A–B. Type locality: Philippines.

Diagnosis: Shell height (left) valve to 70mm; ovate, slightly gibbose. Sculpture of numerous ridges which bear fine, sharp, upright spines with five or six rows bearing slightly longer spines. Colour white with rays of orange or pink from the umbo to the margin. Internally white, with orange and white variegated crenulated margin. Area of attachment moderately large.

Material examined: South Africa: Northern Zululand: 1pv, NM-D8811, off Jesser Point (27°32.6'S; 32°43.3'E), 150m, sandstone rubble, NMDP, 9 Jun 1987; 1pv, 2lv, NM-E3270, off Gypsy Hill (27°48.7'S; 32°39.4'E), 100–125m, amongst broken shell, NMDP, 11 Jun 1988; 1lv, NM-E4069, NE of Liefeldt's Rocks (27°42.9'S; 32°40.9'E) 160m, broken shell, NMDP, 8 May 1988; NM-E4069, off Gobey's Point (27°26.2'S; 32°44.7'E), 120–150m, sandstone rubble, glass sponges, NMDP, 8 May 1988. South Africa: Southern Natal: 1lv, NM-B3943, off Park Rynie, 140m, sponge & rubble, NMDP, Mar 1981; 1lv, NM-B3565, off Park Rynie, 110–130m, eroded shell & conglomerate, NMDP, Mar 1981; 1lv, NM-B3867, off Park Rynie, 140m, sponge rubble, NMDP, Mar 1981; 1lv, 1rv, NM-B3820, dredged off Park Rynie, 120m, rubble

& solitary rubble, NMDP, Mar 1981; 1lv, NM-C1705, dredged off Park Rynie (30°22.8'S; 30°50.5'E), 104m, fine sand, NMDP, 19 Aug 1981; 1rv, NM-C1672, dredged off Park Rynie (30°22.6'S; 30°50.0'E), 124m, some sand, NMDP, 19 Aug 1981; 1lv, NM-D716, off Umlaas Canal (29°58.5'S; 31°00.8'E), 75m, muddy sand, NMDP, 10 Jul 1985. South Africa: Transkei: 1lv, NM-C1203, off Port Grosvenor (39°57.9'S; 31°25.9'E), 120–128m, coarse sand, some mud, solitary coral and shells, NMDP, Aug 1981. Extralimital: 1pv, NM-K2160, Reunion Is., Mascarenes, Cap la Houssaye, 12m in coral holes, J.Drivas, Aug 1987.

Distribution: Indo-Pacific to eastern Transkei.

Habitat: Attached to corals and rocks in deep water (55–150m); only juveniles were dredged in living condition during the NMDP.

Spondylus nicobaricus Schreibers, 1793

Figure 4 C–F

Spondylus nicobaricus Schreibers, 1793: 154 (based on Chemnitz, 1784: pl. 45, fig. 469); Sowerby, 1897: 28; Braga, 1952: 97; Paes da Franca, 1960: 91, pl. 22, fig. 3; Lamprell, 1986: 28 (synonymy), pl. 7, figs 1 A–C. Type locality: Nicobar Islands (Chemnitz, 1784).

Spondylus hystrix Röding, 1798: 195 (cites Chemnitz, 1784: pl. 45, fig. 470); Barnard, 1964: 434; Boshoff, 1965: 137, pl. 3, fig. 2 [in part only]. Type locality unknown [= Nicobar Islands (Chemnitz, 1784)].

Spondylus igneus Fulton, 1915: 354, sp. 51.

Spondylus sp.?; Turton, 1932: 234, pl. 61, no. 1636.

Diagnosis: Shell height (left) valve to 70mm; ovate to elongate-ovate. Sculpture of numerous ridges which bear dense, short, usually sharp, upright or slightly depressed spines; interstices usually with one or two rows of smaller serrated spines. Colour variable, usually white with blotches of black, purple or red, often in radial rays; external colour visible internally. Area of attachment large.

Material examined: Northern Mozambique: 1pv, NM-H361–362, NE Conducia Bay, NE Isla Quissirwa, on rock near small coral area, current, 600mm above LST, K. Grosch, Jan 1963; 1pv, NM-H183, Conducia Bay, Isla Chaca, south shore, under encrusted rock on reef, surf, current, 600mm above LST, K. Grosch, Nov 1967; 1pv, NM-H179, Conducia Bay, Memba Bay, SW of Ponta Nangata, underside encrusted rock slab in reef, LST, K. Grosch, Sept 1963; 1pv, NM-H366, SE Memba Bay, Baixo do Pinda Strait, coral slab on reef, 300mm above LST, K. Grosch, Jan 1969; 1pv, NM-H187, 3pv, NM-H188; 1pv, NM-H365, Conducia Bay, Mocambique Province, K. Grosch, Sept 1975; 1pv, NM-H184, SE Nacala Bay, Fernao Velosa, Mocambique Province, under rock slab in reef, some surf, 600mm above LST, K. Grosch, Nov 1969; 1pv, NM-H180, SW Conducia Bay, N of Chocas, under rock slab on rocky reef offshore, LST, K. Grosch, Mar 1955; 1pv, NM-H360, SW Conducia Bay, N of Chocas, current, some surf, 300mm above LST, K. Grosch, Mar 1956; 1pv, NM-H186, SW

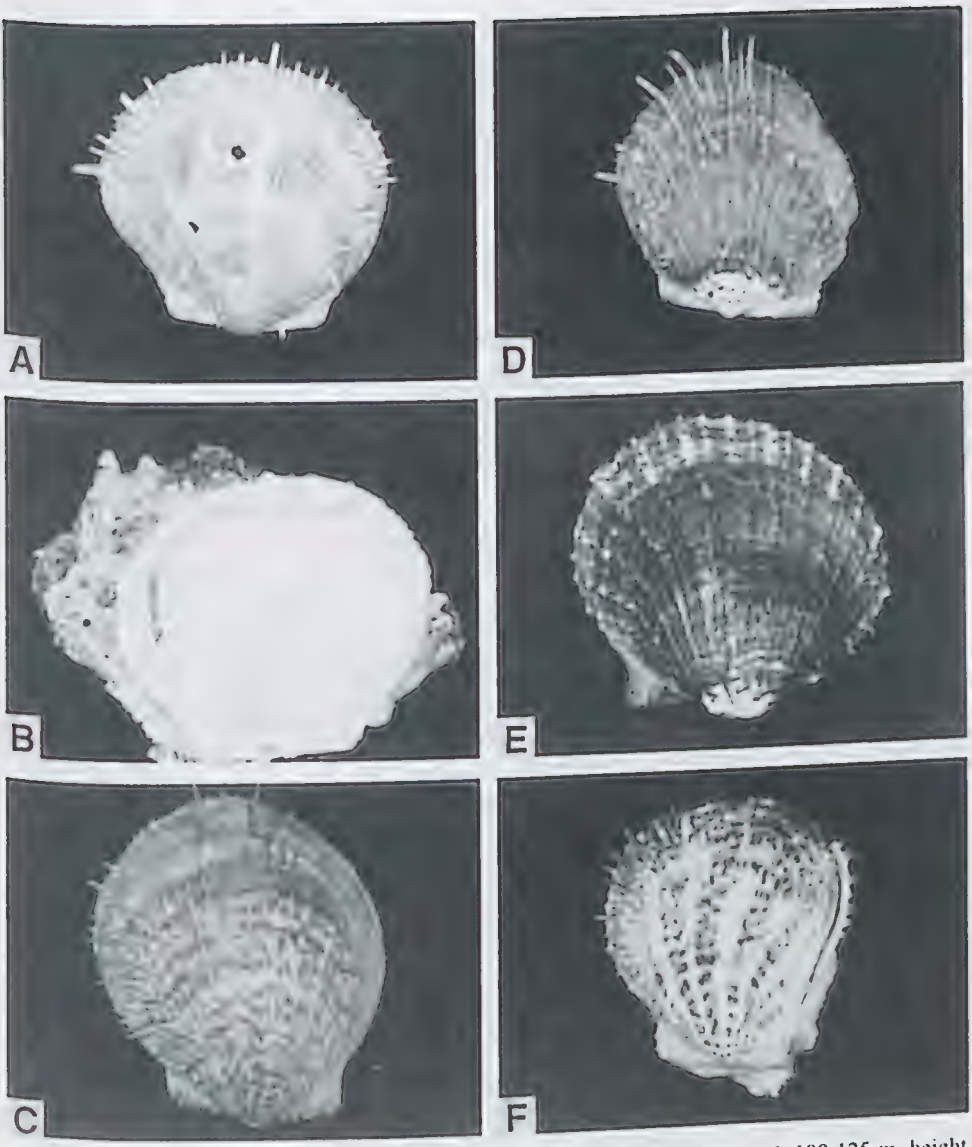

Fig 4. A,B, *S. occidens* Sowerby, 1903, NM-E3270, off Gypsy Hill, Zululand, 100-125 m, height 29.1 mm, length 30.0 mm. C-F, *S. nicobaricus* Schreibers, 1793: C, NM-2404, Durban, Natal, height 61.4 mm, length 55.3 mm; D, NM-9412, off Kosi Bay, Zululand, 9-17 m, height 41.7 mm, length 37.7 mm; E, NM-H364, Mozambique Bay, 1 m below LST, height 32.7 mm, length 34.9 mm; F, NM-J5106, Bazaruto Is, Mozambique, hieght 40.3 mm, length 38.0 mm. Measurements exclude spines.

Conducia Bay, N of Chocas, side of encrusted rock in reef, 300mm below LST, K.Grosch, Sept 1958; 3pv, NM-H176 & H365, Conducia Bay, K. Grosch; 1pv, NM-H356, SW Conducia Bay, NW of Chocas, under rock in coral area, current, some surf, 600mm below LST, K. Grosch, Oct 1969; 1pv, NM-H178, SW Conducia Bay, NW of Chocas, rock inshore, *Thalassodendron* and gravel, K. Grosch, Mar 1968; 1pv, NM-H181, Conducia Bay, N of Inhaca Grande, under rock in tidal pool, current, 600mm

above LST, K. Grosch, Nov 1967; 1pv, NM-H364, SE Mozambique Bay, W Banco de Sancul, sandy area amongst *Thalassodendron*, little surf, 900mm below LST, K. Grosch, Nov 1968; 1pv, NM-H363, SE Lunga Bay, off Quieirua, under rock slab in rocky/*Thalassodendron* area, 300mm above LST, K. Grosch, Aug 1968; 1pv, NM-H185, SE Lunga Bay, off Quieirua, under side of boulder on reef, some surf, LST, K. Grosch, Apr 1968; 1pv, NM-H182, Lunga Bay, SE Ponta Calajulo, on dead coral, some surf, current, LST, K. Grosch, Oct 1967; 1pv, NM-H355, SE Lunga Bay, Calajulo, K. Grosch, Dec 1974; 1pv, NM-H359, SE Memba Bay, W of Nangata, under rock in gravel, next to reef, surf, current, LST, K. Grosch, Mar 1949; 1pv, NM-H177, Mozambique Bay, S Isla de Sena, under rock slab on reef, some surf, LST, K. Grosch, Nov 1968; 1pv, NM-J9402, Quirimba Arch, NW Quisiva Is, R. Kilburn, 27 Sept 1984. Southern Mozambique: 1pv, NM-G3163, Bazaruto Archipelago, Santa Carolina Is., W coral reef, R. Kilburn, Aug 1974; 2pv, NM-J5107, sandbanks W of central Bazaruto Is., amongst oysters and *Thalassodendron*, LST, E. Roscoe, May 1975; 1pv, NM-J5105, West Bay, Santa Carolina, E. Roscoe, 5 Nov 1975; 5pv, NM-J5106, N Reef, Bazaruto Is, E. Roscoe, Jan 1972; 4pv, 1rv, 7lv, NM-4501, Inhaca Is., Bay of Maputo, P. Boshoff. South Africa: Zululand: 1pv, NM-4502, Kosi Bay, F. Toppin, Mar 1906; 1pv, NM-D9493, between Kosi Bay and Bhanga Nek, No 13 Reef, drop-off at outer edge, 12–20m, D. Herbert & NPB, Jul 1987; 4lv, NM-4605, Bhanga Nek, O. Bourquin, Jan 1965; 6pv, 2lv, NM-D5196, Sodwana Bay, Two-mile Reef, 10–15m, D. Herbert, Oct 1986; 1pv, 2lv, NM-D5263, Sodwana Bay, Nine-mile Reef, 6–15m, D. Herbert, Oct 1986; 3pv, 4lv, NM-D5562, Mission Rocks, intertidal, R. Kilburn, D. Herbert, 24–30 Apr 1987. South Africa: Natal: 25pv, NM-A190, Salt Rock, Umhlali district, among and inside oysters on side of swimming bath, 300–600mm, R. Kilburn, Mar 1973; 1pv, NM-A5679, Thompson's Bay, Umhlali, tidal swimming pool, R. Kilburn, Jan 1976; 6pv, 3lv, NM-4499, Durban, W. Falcon; 6pv, NM-2401–02, NM-2404–05, NM-2860, Durban, H. Burnup; 2pv, NM-B1659, NM-1658, Vetch's Pier, Durban, B.J. Young, Aug 1973 & Mar 1974; 1pv, NM-E8493, Treasure Beach, N of Reunion Rocks, under rock in large tidal pool, T. Stewart, Aug 1989; 1pv, NM-A3717, Reunion Rocks, N of Isipingo, R. Cock, 1965; 2pv, NM-8073, Isipingo, in tidal swimming pool, R. Kilburn; 1pv, NM-A2973, Mtwalume, rock pools, R. Kilburn, Jun 1972; 1pv, NM-D2580, T. O. Strand, 2km N of Port Edward, R. Kilburn & D. Herbert, May 1986. South Africa: Transkei: 2pv, NM-C8377, Mbotyi, D. Herbert & R. Kilburn, Jun 1985; 1lv, NM-B7018, Coffee Bay, W. Tyson; 1pv, NM-E6021, between Mzamba & Mtentu Rivers, J. Stannard, Jul 1988; 1lv, NM-B4960, Msikaba, among LT rocks on island, R. Kilburn, 10 Feb 1978. South Africa: Eastern Cape Province: 2lv, NM-D4657, Port Alfred, ex Albany Mus, J. Hutt colln 1980.

Distribution: Tropical Indo-West Pacific to Transkei, with an occasional juvenile settling as far south as the eastern Cape Province (Port Alfred).

Habitat: Under rocks and inside empty oyster shells in low tide pools and down to about 20m.

Remarks: *Spondylus nicobaricus* is the commonest member of the genus in south-eastern Africa. It is extremely variable in sculpture and colouration; whereas tropical Indo-Pacific specimens are predominantly either all-white, white with dark spotting at the umbo or white with radial purple-red rays (= form *radians*), south-east African

specimens include the *radians* form, but vary in colour to deep purple-red with white umbonal area and purple-red spotting, with dark internal margins. In addition, younger specimens usually have long, thin, slightly recurved spines, with some similar but slightly shorter spines in the interstitial areas. *Spondylus igneus* Fulton,1915 from Mauritius, cannot be separated from the dark coloured specimens of *S. nicobaricus* examined during this study and must be relegated to synonymy with that species. Boshoff (1965) ascribed extremely wide sculptural variation to this species, but his photographs show a mixture of *S. nicobaricus* and *S. groschi*. The single juvenile valve (diameter 6mm) recorded from Port Alfred by Turton (1932) is referable here, according to his photograph.

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Book review

Australian Marine Shells. Prosobranch Gastropods. Parts 1 and 2. By B.R. Wilson. Odyssey Publishing, Kallaroo, W.A. 1993 and 1994. Price: $125 per volume. ISBN 0 646 15225 4 (set).

We have seen a few books on Australian molluscs in the last two decades but this work is surely worthy of land-mark status and is superior to most similar books that have appeared world-wide. The two volumes by Barry Wilson, Australia's senior malacologist, are the most lavish we have seen since Wilson and Gillett's *Australian Shells* appeared in 1971. These two superbly illustrated books largely fill a long recognised need - a reliable identification guide to the majority of the larger-sized Australian marine shelled gastropods. They are a must for anyone interested in shells, or in identifying Australian gastropods.

The books are sprinkled with magnificant photos of living animals - and for this alone they are worthwhile. Another important aspect is that the two volumes provide access to identifications of common faunal elements that were previously not covered in the popular or semi-popular literature. This work is thus important as a source for identifications in many groups not reviewed in the literature elsewhere. While some of the species taxonomy and choice of generic names can certainly be argued about, this is a fine first attempt at providing an accessible source of names for many groups. Probably for this reason, more than any other, this work will be a valued reference source for many years to come. However, this is certainly not, as Barry Wilson would be the first to admit, the final work on Australian gastropods. Wilson estimates that there are perhaps 10,000 Australian species of marine molluscs. However, when all the deepsea and small and minute species are taken into account the number is probably closer to twice this, although a very large proportion remain unnamed. Gastropods comprise at least 80% of molluscs and according to the flyer these volumes deal with about 2400 species. Thus these volumes cover between only 13% and 30% of Australian gastropods, depending upon which estimate is accepted. Clearly there is still much work to be done!

This work only includes "prosobranch" gastropods - as indicated by the subtitle. This may be a source of confusion for those who read only the main title of the book and fail to see the small print subtitle; or for those who do not know what consitutes the paraphyletic Prosobranchia. Consequently, the book excludes not only all non-marine gastropods, as well as the shell-less seaslugs, but the shelled opisthobranchs and marine pulmonates are also omitted. Volume 1 deals with the non-neogastropods and volume 2 the neogastropods.

The first volume contains a brief (19 pages) introductory section on collecting, taxonomy and classification and a short list of basic references for these subjects. There is a list of journals and the addresses from which they can be obtained - some of which are incorrect (including the address for this journal). The very short section dealing with classification incorporates some of the ideas on gastropod classification introduced in the late 1980s. The "subclass" Heterobranchia is erroneously recognised as separate from the "subclasses" Opisthobranchia and Pulmonata. The concept of Heterobranchia introduced by Haszprunar (1985) *includes* the euthyneuran groups (pulmonates and opisthobranchs) which are reduced to a lesser rank. The name Docoglossa is used for the Patellogastropoda (see Lindberg, 1988) and Lindberg's classication for this group is not

used, although it was introduced in the same volume as Ponder and Warén's (1988) treatment of caenogastropods. It is from this same volume which Wilson states he "follows arrangements recommended in those papers ...". Lindberg (1988) uses the family name Lottiidae for the Australian taxa usually included in the Acmaeidae. In the use of Docoglossa, and in other features of the classification of the "lower" prosobranchs, Wilson generally seems to have followed Haszprunar's (1988) classification. Neritimorpha (more correctly called Neritopsina) is correctly recognised as a distinct group. The treatment of the almost certainly polyphyletic Cocculiniformia suffers from the author apparently being unaware of Marshall's (1985) review of the New Zealand and New South Wales taxa. Only two species are included by Wilson, one of which (*Notocrater meridionalis*) is *Propilidium tasmanicum*, a member of the Lepetidae in the Patellogastropoda. The other is *Tectisumen tasmanica* which is a member of the Lepetellidae (Lepetelloidea) (B. Marshall, *pers. comm.*). Marshall recognises two cocculinids (Cocculinoidea), four pseudococculinids (Lepetelloidea), and a caymanabyssiid from NSW, the rest of the Australian fauna not being covered in his review.

Other quibbles with the higher classification adopted include the use of the name Archaeogastropoda instead of Vetigastropoda and Pleurotomarioidea to encompass the distinct Scissurelloidea and Haliotoidea. The traditional use of Archaeogastropoda encompasses the patellogastropods and neritopsines so the use of the alternative Vetigastropoda is preferred. The recognition of Seguenzioidea as a group of higher rank than Trochoidea etc. (in this case a "suborder") is now no longer justified (see also Haszprunar, 1993).

Many of the families of small and minute species are mentioned, and in some cases an example is illustrated. It is, however, surprising that at least some of the larger species belonging to the Rissoidae were not illustrated, several exceeding 10mm in length and many being extremely common. In contrast, families with similar sized species - cerithiopsids, triphorids, marginellids, columbellids and even eulimids, are dealt with in more detail. In these cases an overview of morphological diversity is provided but, with few exceptions, the treatment of small species is generally inadequate for reliable identifications.

The books are clearly aimed in large part at shell collectors and this may be the reason why there is a considerable emphasis on the cones, cowries and volutes (one third of the plates, although only 12% of the text). There is, however, also a very good and unequalled coverage of some of the "less popular", groups, particularly those of larger size. However, there is still a significant discrepency in the treatment of some groups. For example the important and very large Turridae (*sensu lato*) are given a rather cursory treatment - especially if contrasted with the exhastive treatment given the terebrids and the cones (the latter group should probably be considered a mere subgroup of the turrids).

The 97 plates are all in colour and the photography (by Patrick Baker) of very good quality, although perhaps not quite as good as that seen in a few other recent shell books. Unfortunately, as in many similar books, some of the specimens illustrated are at about life-size and are too small to discern detail, thus being of questionable value for identification. Whereas some species are shown in two or more views others are illustrated from a single view when they need more - e.g. only ventral views of the fissurellid limpet

Montfortula pulchra and the patellid *Patella peronii* are shown. Carina Wilson's nearly 600 drawings of the smaller species grace the books and help provide some of the meat that puts these volumes well above standard shell books.

I am not going to pick out species and genus-level quibbles - in general Wilson has done an excellent job. However, there is, in preparing a book like this, not only the massive task of finding published literature but keeping up with it as sections are written. In the main the important literature is well covered but minor literature is not - thus readers will often not be able to source the paper which justifies the taxonomy used. Readers may also wish to update the taxonomy used and, for this purpose, Ian Loch's "Taxonomic Turnover" in *Australasian Shell News* (ASN) provides a regular excellent review of new taxonomic literature.

In conclusion, I strongly recommend these volumes as the best that have appeared on Australian gastropods. They will be an essential reference source for anyone interested in our fauna.

Below I note a few changes that have occurred since the book was prepared for publication, and also list some papers that were not included which bear on the taxonomy used. I have not included points noted by John Healy's review of volume 1 (ASN 87, 1994) and this list is not in any way intended to be exhaustive. It is hoped, however, that readers will be able to use it as a start to a supplementary reference source for the two volumes.

Volume 1.

Marshall (1988) describes several new taxa which he includes in Skeneidae and a vitrinellid from NSW.

The Dialidae encompasses a number of taxa that should be included in the Litiopidae (e.g. the species *"Diala" monile* - see Ponder and de Keyzer, 1992 for details).

Seguenzidae - there have been several recent papers on this family, two of them by Marshall (see Marshall, 1991) for details and references.

The Fossariidae is now a subfamily of the Planaxidae (Houbrick, 1990) and, since the publication of volume 1, Obtortionidae is included in Scaliolidae (Ponder, 1994). Houbrick (1993) reviewed the genera related to *Bittium.*

There has been a major review of the taxonomy of the genus *Bembicium* (Reid, 1988) and *Peasiella* (Reid, 1989b). Bandel and Kadolsky (1982) advocated using *Nodilittorina* for many of the Indo-West Pacific and Australasian taxa previously (and in this volume) referred to *Littorina* and this has been supported by Reid's (1989a) phylogenetic analysis of the family.

Skeneopsidae should be removed from the Australian fauna - it is an exclusively western Atlantic-Mediterranean group. The inclusion of *Starkeyna* in this family is certainly wrong, that genus probably being a synonym of (or at least closely related to) *Vitrinella.*

Truncatelloidea has been replaced by Rissooidea (ICZN Opin. 1664).

Assimineidae - In the brief coverage of this family one of the species names is incorrect. *Assiminea tasmanica* is now *A. buccinoides* (see Ponder and Clark, 1989) and

A. brazieri is *Hydrococcus brazieri* (family Hydrococcidae).

Barleeidae was split into Barleeidae and Anabathridae by Ponder (1988) - the species illustrated is actually an anabathrid and it is this group to which most of the Australian taxa belong. Also, the Australian monotypic family Emblandidae is not listed.

Loch (in ASN 71, 1990) summarised the distributions of Australian species of Strombidae and added additional taxa to the fauna but these amendments have not been included.

Suprisingly, Struthiolariidae (with the endemic genus *Tylospira*) has been omitted - presumably as an oversight. Darragh (1991) has reviewed the Australian Recent and fossil species of *Tylospira.*

There is no reference to the important and relevant paper on New Zealand cerithiopsids by Marshall (1978).

Loch (in ASN 78, 1992) revises the species of *Ataxocerithium.*

Two very important uncited papers on epitoniids (Kilburn, 1985 and Bouchet and Warén, 1986) are relevant to our fauna.

Several papers describing Australian taxa in Eulimidae have been published (e.g. Warén 1980a, 1980b, 1981, 1983; Warén and Crossland, 1991; Ponder and Gooding, 1978).

Haloceratidae (Warén and Bouchet, 1991) is not mentioned. This family includes several Australian species.

Volume 2.

The suggestion by Ponder and Warén (1988) that Fasciolariidae, Nassariidae, and Melongenidae be treated as subfamilies of Buccinidae has been followed. Ongoing studies on the phylogeny of this group (using molecular data) by M. G. Harasewych and his coworkers suggests that this is an oversimplification but to date no alternative classification has been proposed.

Kool (1993) revises the classification of the group of genera similar to *Thais* and *Rapana* ("Thaidinae" = Rapaninae).

Hexaplex conatus - it is noted (p. 31) that "the radula is not yet described" but this is now done (E. Vokes, ASN 82, 1993).

Loch (ASN 79, 1992) revises and corrects some of Cernohorsky's treatment of Australian Nassariinae. While some of these amendments have been made this useful article is not cited and additional species to those covered in the book are recorded from Australia.

The taxa included in Olividae have been subdivided into three distinct groups - Olividae, Olivellidae and Pseudolividae by Kantor (1991) based on anatomical differences.

Mitridae - *Mitra carbonaria* is cited as being "very variable". Ian Loch (ASN 65, 1989):4) has shown that Cernohorsky's concept of *M. carbonaria* consists of at least two species, *M. carbonaria* and *M. badia.*

Taylor *et al.*(1993) recognise four families for taxa usually included in the Turridae (see Taxonomic Turnover, ASN 85/86, 1994) for details). Kilburn's important papers on South African turrids published within the last 10 years deserve mention as being relevant to the Australian fauna. Sysoev and Kantor (1988) describe a large turrid from south of Tasmania (*Aforia tasmanica).* Kosuge's series of papers from 1977 to 1994 in the Bulletin of the Institute of Malacology, Tokyo on the north western turrid fauna are not referenced, although some of the species he recorded are included. Loch (ASN 80, 1992) has reviewed the Australian species of *Leinardia* and *Hemilienardia* - two genera not included in the book.

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W.F. Ponder
Australian Museum

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Kohn, A. J. and Amalsi, K. N. 1993. Comparative ecology of a biogeographically heterogeneous *Conus* assemblage. Pp. 523-538. In: Wells, F. E., Walker, D. I., Kirkman, H. and Lethbridge, R. The Marine Flora and Fauna of Rottnest Island, Western Australia. Western Australian Museum, Perth.

Short, J. W. and Potter, D. G. 1987. Shells of Queensland and the Great Barrier Reef. Marine

Gastropods. Golden Press, Drummoyne, NSW.

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Contents

W.B. Rudman
The Chromodorididae (Opisthobranchia: Mollusca) of the Indo-West Pacific: further species from New Caledonia and the *Noumea romeri* colour group 1

A.H. Scheltema
Falcidens poias, a new species of chaetoderm Aplacophora from Rottnest Island, Western Australia (Chaetodermorpha, Chaetodermatidae) 45

E.H. Vokes
Two additional species of *Dermomurex* (Gastropoda: Muricidae) from southern Australia 51

A.M. de Frias Martins
A new species of *Pythia* Röding, 1798 (Pulmonata, Ellobiidae) from New Ireland, Papua New Guinea 59

B. Scott
Redescription of *Fastosarion superba* (Cox, 1871), with descriptions of two new species of *Fastosarion* from northern Queensland (Pulmonata: Helicarionidae) 69

K.L. Lamprell and R.N. Kilburn
The Recent Spondylidae of South Africa and Mozambique, with the description of a new species (Mollusca, Bivalvia, Pectinoidea) 81

Book review 97

Instructions to authors 103